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Wyoming AQMA Area Source Inventory

PEDCo-Environmental Specialists, Inc Cincinnati, Ohio

Prepared for

Environmental Protection Agency, Denver, Colo Region VIII

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WYOMING AQMA
AREA SOURCE EMISSION
INVENTORY



U.S. ENVIRONMENTAL PROTECTION AGENCY
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AIR & HAZARDOUS MATERIALS DIVISION
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**WYOMING AQMA AREA SOURCE
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U.S. Environmental Protection Agency
Region VIII, Denver, Colorado

Prepared by

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Material included in this report was not originally intended for publication, but to document the data sources and assumptions made in preparing the area source emission inventory. Therefore, the text may be sketchy and the report more useful as a resource document than a general procedures manual for emission inventories. It should also be pointed out that the area source emission inventory is subject to frequent updating so that data presented herein may soon become obsolete.

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SUMMARY

This report presents a base year and projected air pollutant emissions inventory of area sources in the two Wyoming Air Quality Maintenance Areas (AQMA). The Powder River AQMA encompasses Campbell and Converse Counties and is designated for particulates and photochemical oxidants. The Sweetwater AQMA includes only Sweetwater County and is designated for particulates and SO₂.

Designation by the Wyoming Department of Environmental Quality and U.S. Environmental Protection Agency indicates that there is a possibility that future growth in the AQMA may cause the National Ambient Air Quality Standards to be exceeded despite enforcement of source control regulations. The area source inventory is to be used in a detailed analysis of each AQMA to better determine the impact of future growth on air quality.

A base year of 1974 was specified for the inventory in order that it be consistent with the time frame of the point source emission inventory also being prepared. At the time that the inventory was completed, 1974 was the most recent year for which data could be obtained.

The area source categories used in the inventory include all conventional source categories described in APTD-1135, Guide for Compiling a Comprehensive Emission Inventory, plus some additional categories of fugitive dust sources. Two of the conventional categories, incinerators and vessels, were excluded since these sources are negligible in the AQMA's. Special consideration was given to the estimation of emissions from two industrial processes, pipeline compressors and heater treaters, and from the burning of spilled oil in oil fields. An attempt was made to develop a particulate emission factor for the open burning of crude oil in a sump. Also

particulate emissions from mining operations were not included in this inventory, since they will be inventoried as point sources.

The base year and projected annual emissions are shown in Tables 1 through 3 for Campbell, Converse, and Sweetwater counties. Each section of this report shows the data and methodology used to estimate emissions, base year emissions, and projections for each source category.

The area source categories showing the greatest particulate emissions are fugitive dust sources. Fugitive dust accounts for about 98 percent of the area source particulate emissions in the Powder River Basin AQMA and 98 percent in the Sweetwater AQMA. Unpaved roads are responsible for most of the fugitive dust emissions.

Mobile sources account for about 85 percent of the identified hydrocarbon area source emissions in the Powder River Basin AQMA, and they also account for about 72 percent of the SO₂ emissions in the Sweetwater AQMA.

The procedure used to project emissions was to apply growth factors to the base year emissions for each source category. Separate growth factors were developed for each category for 1975, 1980, and 1985.

Particulate emissions are shown to increase from 1975 to 1985 by about 139 percent in Campbell County and about 38 percent in Converse and Sweetwater Counties. Hydrocarbon emissions will remain about the same in Campbell County and decrease about 33 percent in Converse County from 1975 to 1985. SO₂ emissions in Sweetwater County are shown to remain almost constant for the next ten years.

Table 1. CAMPBELL COUNTY BASE YEAR AND PROJECTED EMISSIONS

Source Category	Particulates (tons/yr)				Hydrocarbons (tons/yr)			
	1974	1975	1980	1985	1974	1975	1980	1985
Bituminous Coal	98	99	104	109	98	99	104	109
Distillate Oil	25	31	80	103	5	6	16	21
Residual Oil	17	21	53	68	2	3	7	9
Natural Gas	8	10	20	25	7	8	16	20
Other Fuels	5	6	11	14	2	2	5	6
Open Burning	17	17	17	17	-	-	-	-
Highway Vehicles	90	104	145	148	1450	1575	1953	1192
Off-Highway Vehicles	18	32	41	45	72	90	113	125
Railroads	37	37	176	232	141	141	664	877
Aircraft	-	-	-	-	2	2	3	4
Industrial Processes	255	255	255	255	309	309	309	309
Evaporative Losses	-	-	-	-	6254	6274	6394	6454
Unpaved Roads	27836	32669	56628	67944	-	-	-	-
Agriculture	826	826	846	865	-	-	-	-
Construction	1486	2369	2893	3117	-	-	-	-
Aggregate Storage	5	5	5	5	-	-	-	-
Dust from Paved Roads	676	777	1399	1751	-	-	-	-
Total	31399	37258	62673	74698	8342	8509	9584	9146

Table 2. CONVERSE COUNTY BASE YEAR AND PROJECTED EMISSIONS

Source Category	Particulates (tons/yr)				Hydrocarbons (tons/yr)			
	1974	1975	1980	1985	1974	1975	1980	1985
Bituminous Coal	8	8	8	9	8	8	8	9
Distillate Oil	12	12	18	21	2	2	3	5
Residual Oil	7	7	11	12	1	1	2	2
Natural Gas	4	4	5	5	3	3	4	4
Other Fuels	3	3	4	4	6	6	9	9
Open Burning	62	62	62	62	-	-	-	-
Highway Vehicles	80	82	83	70	1290	1243	1116	552
Off-Highway	17	19	31	19	55	58	73	60
Vehicles								
Railroads	9	9	148	206	34	34	558	776
Aircraft	-	-	-	-	2	2	3	4
Industrial	84	84	84	84	85	85	85	85
Processes								
Evaporative	-	-	-	-	1374	1375	1397	1401
Losses								
Unpaved Roads	15039	15490	21060	22113	-	-	-	-
Agriculture	1045	1045	1055	1065	-	-	-	-
Construction	857	869	925	866	-	-	-	-
Aggregate	8	8	8	8	-	-	-	-
Storage								
Dust from Paved	642	655	860	892	-	-	-	-
Roads								
Total	17877	18357	24362	25436	2860	2817	3258	2907

Table 3. SWEETWATER COUNTY BASE YEAR AND PROJECTED EMISSIONS

Source Category	Particulates (tons/yr)				Sulfur Dioxide (tons/yr)			
	1974	1975	1980	1985	1974	1975	1980	1985
Bituminous Coal	25	24	17	13	24	22	16	12
Distillate Oil	24	27	36	39	70	78	105	111
Residual Oil	11	12	17	18	91	102	137	146
Natural Gas	42	47	63	67	3	3	4	4
Other Fuels	6	7	9	9	2	2	3	3
Open Burning	3	3	3	3	-	-	-	-
Highway Vehicles	368	393	379	335	141	151	184	176
Off-Highway Vehicles	30	33	44	47	34	37	50	53
Railroads	200	200	200	200	455	455	455	455
Aircraft	4	4	5	6	2	2	3	4
Industrial Processes	53	53	53	53	2	2	2	2
Unpaved Roads	24588	27000	33678	34975	-	-	-	-
Agriculture	25	25	25	26	-	-	-	-
Construction	8588	9250	11345	11896	-	-	-	-
Aggregate Storage	108	108	108	108	-	-	-	-
Dust from Paved Roads	2325	2488	2999	3139	-	-	-	-
Total	36400	39674	48981	50934	824	854	959	966

1. BITUMINOUS COAL

Data Inventory and Methodology

Coal consumption was determined by two methods: (1) degree-day heating method for residential and apportioning state coal consumption totals for commercial; (2) contacting major county distributors. The distributor's total sales in 1974 for each county are:

Campbell - 9,800 tons (Ref. 32) and (Ref. 34)
Converse - 845 tons (Ref. 34)
Sweetwater - 2,500 tons (Ref. 33)

This data reflects residential customers for Campbell and Converse, and residential and commercial customers for Sweetwater.

The following describes the procedure used to determine coal consumption for residential, commercial-institutional, and industrial.

Residential:

Residential coal consumption was calculated using the degree-day heating method (Ref. 11). The general equation is:

$$RFC = (DU) \times (DD) \times (HRF) \times (R) \quad (\text{eq. 1})$$

where RFC - residential fuel consumption, tons

DU - dwelling units

DD - degree-days

HRF - heating requirement factor, tons of coal per dwelling unit per degree day

R - correction factor for number of rooms per dwelling unit, average no. of rooms/5.0 rooms

The heating requirement factor for tons of coal burned is 0.0012 tons/dwelling unit/degree day (Ref. 11).

The following is the number of dwelling units and degree-days for each county and the state, used to calculate coal consumptions.

	<u>State</u>	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
1970 dwelling units using coal (Ref. 1)	3,454	245	61	107
1974 dwelling units using coal	3,592	255	63	80
Average rooms per dwelling unit (Ref. 1)	4.7	4.5	4.8	4.4
Average annual 1974 heating degree-days (Ref. 8)	7,416 State avg.	7,332 Sheridan	7,584 Casper	7,721 Lander
1974 Residential coal consumption (tons/year)	<u>30,047</u>	<u>2,019</u>	<u>550</u>	<u>652</u>

The State of Wyoming and both Campbell and Converse counties have had a 1% increase per year in coal consumption (Ref. 32). Sweetwater county had a 25% decrease in coal consumption from 1970 to 1974 (Ref. 33). The degree-days for each county were determined from the 1974 Climatological Summary of the nearest National Weather Service (NWS) recording station and indicated accordingly. The state degree-days were determined by averaging all NWS stations in the state.

Comparing the calculated coal consumption for residential use with the distributor's sales for Campbell and Converse indicates the distributors sales are higher. Since the major distributors were contacted and their data is considered more accurate, the distributor's sales were used to calculate emissions.

Sweetwater distributor sales contains both residential and commercial. Therefore, no comparison is possible.

Commercial-Institutional:

Since the 1974 calculated residential coal consumption of 30,047 tons is greater than the state retail dealers consumer use for 1974 of 24,000 tons (Ref. 4), it was assumed that there is no commercial-institutional area source coal consumption. The exception is Sweetwater County where a total residential and commercial distributor's sales for 1974 was used to calculate emissions.

Industrial:

It was assumed that all industrial coal users burned large enough quantities to be included as point sources. Thus, industrial coal combustion area source emissions were assumed to be negligible.

Base Year Emissions

Since the majority of the coal consumption is residential, emission factors for hand-fired units were used (Ref. 12):

Particulates = 20 lb/ton

Hydrocarbons = 20 lb/ton

Sulfur dioxide = 38S lb/ton, where

S = percent sulfur, 0.5% average (Ref. 37)

Applying these emission factors to the previously-determined coal consumption values yields the following annual emissions.

	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
1974 area source coal consumption	9,800	845	2,500
1974 emissions (tons/year)			
- particulate	98	8	25
- hydrocarbon	98	8	n.d.
- sulfur dioxide	n.d.	n.d.	24
n.d. = not determined			

Projections

Residential and commercial-institutional coal usage in Sweetwater County is steadily declining at a rate of about 6 percent per year due to home heating conversion to natural gas, LPG, and electricity. In Campbell and Converse Counties, the availability of inexpensive coal from strip mining activity has created an increase in residential coal consumption of 1 percent per year. Based upon these growth rates, future coal usage and resulting emissions are as follows:

<u>County</u>	<u>Year</u>	<u>Coal Usage (tons/yr)</u>	<u>Emissions (tons/yr)</u>			
			PART	SO ₂	HC	GF
Campbell	1975	9,899	99		99	1.01
	1980	10,403	104		104	1.06
	1985	10,934	109		109	1.11
Converse	1975	853	8		8	1.01
	1980	897	8		8	1.06
	1985	943	9		9	1.11
Sweetwater	1975	2,350	24	22		0.94
	1980	1,725	17	16		0.69
	1985	1,266	13	12		0.50

GF = growth factor.

2. DISTILLATE OIL

Data Inventory and Methodology

Distillate oil consumption was determined by two methods:

(1) degree-day heating method for residential and apportioning state distillate oil consumption totals for commercial and industrial; (2) contacting the major distributor in each county. The distributor's total sales in 1974 for each county are:

	<u>Distillate Oil (gallons)</u>		
	<u>Residential</u>	<u>Commercial</u>	<u>Industrial</u>
Campbell (Ref. 38)	20,000 (res. & comm.)		n.d.
Converse (Ref. 39)	1,500	n.d.	1,200,000
Sweetwater (Ref. 40)	5,000	733,000	400,000

n.d. = not determined

The following describes the procedure used to determine distillate oil consumption for residential, commercial-institutional, and industrial.

Residential:

Residential distillate oil consumption was calculated using the degree-day heating method (Ref. 11). The heating requirement factor for gals of oil burned per dwelling unit per degree-day is 0.18 (Ref. 11). The following is the number of dwelling units for each county used to calculate distillate oil consumption.

	<u>State</u>	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
1970 dwelling units using distillate oil (Ref. 1)	3,572	69	44	23
1974 dwelling units using distillate oil	2,500	48	31	12
1974 residential distillate oil consumption (gals/yr)	3,137,000	57,000	40,600	14,700

The average rooms per dwelling unit and average annual degree-days used to calculate consumption are shown in chapter 1. Campbell County had a 30% decrease in dwelling units using distillate oil from 1970 to 1974 (Ref. 38), and it was assumed that Converse County also had the same decrease. Sweetwater County had a 50% decrease from 1970 to 1974 (Ref. 40), and it was assumed that the state had a 30% decrease from 1970 to 1974.

Comparing the calculated distillate oil consumption for all three counties with the major distributor's sales for residential use, indicates that the calculated total is higher than the distributor's sales. Since only one distillate oil distributor per county was contacted, this method only accounts for part of the total county sales. Therefore, the calculated values were used for residential distillate oil consumption for all three counties.

Commercial-Institutional:

Commercial-institutional distillate oil consumption was calculated by apportioning the state distillate oil commercial consumption by county/state population. State residential and commercial distillate oil consumption for area sources was determined from 1973 published data (Ref. 6), where 1973 data was assumed to be representative of 1974. Point source contribution for commercial-institutional fuel usage was assumed to be negligible.

State distillate type heating oil (Ref. 6)	887,000 bbls = $37,254 \cdot 10^3$ gals
State distillate used by military (Ref. 6)	8,100 bbls = $9,198 \cdot 10^3$ gals
State kerosene used for heating (Ref. 6)	219,000 bbls = $340 \cdot 10^3$ gals

1974 state residential and commercial distillate oil consumption	46,792 · 10 ³ gals
1974 state residential distillate oil consump- tion (subtract)	3,137 · 10 ³ gals
1974 state commercial- institutional distillate oil consumption	43,655 · 10 ³ gals

The following is the apportioned commercial-institutional distillate oil consumption by county.

	<u>State</u>	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
1974 Population (Ref. 3)	359,000	11,900	7,100	25,900
1974 commercial- institution distil- late oil consumption (10 ³ gallons/year)	43,655	1,447	863	3,149

Again, the calculated is higher than the distributors sales. Since all distributors were not contacted, the calculated consumption was used.

Industrial:

Industrial distillate oil consumption was calculated by apportioning state industrial distillate oil consumption by county/state mining, contract construction, and manufacturing employees. State industrial distillate oil consumption for point and area sources was determined from the following 1973 published data, where 1973 data was assumed to be representative of 1974.

State industrial use (Ref. 6)	448,000 bbls = 18,816 · 10 ³ gals
State oil companies' use (Ref. 6)	406,000 bbls = 17,052 · 10 ³ gals
1974 state point & area source industrial distillate oil con- sumption	35,868 · 10 ³ gals

The following is the apportioned industrial distillate oil consumption by county, assuming the 1973 ratio of county to state total employees is representative of 1974.

	<u>State</u>	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
Mining, construction, and manufacturing employees (Ref. 2)	27,986	1,430	512	4,435
1974 point and area source industrial distillate oil consumption (10 ³ gals)	35,868	1,833	658	5,684
1974 point source industrial distillate oil consumption (10 ³ gals) (Ref. 41)		<u>0</u>	<u>10</u>	<u>5,604</u>
1974 industrial distillate oil consumption (10 ³ gals/yr)		1,833	648	80

Comparison of calculated consumption with distributor sales in Converse and Sweetwater Counties shows the sales to be greater than the calculated. This is attributed to distributor sales outside the county. Therefore, the calculated industrial distillate oil consumption was used.

Residential, Commercial-Institutional, Industrial:

The following is the total distillate oil consumption in 1974 used to calculate area source emissions.

1974 Area Source Distillate Oil Consumption (gals/yr)

Campbell - 3,337,000
 Converse - 1,551,600
 Sweetwater - 3,243,700

Base Year Emissions

The emission factors for distillate fuel oil combustion are as follows (Ref. 12):

Emission Factors (lb/10³ gals)

Particulate - 15
Hydrocarbons - 3
Sulfur dioxide - 43 (assume 0.3% sulfur)

Applying these emission factors to the county distillate oil consumption yields the following emissions:

1974 Emissions (tons/year)

Campbell: Particulate - 25
 Hydrocarbon - 5
Converse: Particulate - 12
 Hydrocarbon - 2
Sweetwater: Particulate - 24
 SO₂ - 70

Projections

It is assumed that residential distillate fuel oil consumption from 1974 to 1985 will remain almost constant.

Oil is not a commonly used residential fuel in any of the AQMA counties (less than 3 percent of all homes) and may be replaced by other lower cost fuels.

Industrial and commercial-institutional growth factors for Campbell and Converse Counties were determined from employment projections of permanent and service workers (Ref. 56). These employment projections were made for three alternative futures of industrial development. The intermediate alternative future was used to determine the growth factors.

Since there are no current industrial and commercial growth projections for Sweetwater County, population growth factors were used (Ref. 57). Wyoming Department of Environmental Planning & Development (DEPAD) is currently developing growth data for Sweetwater County, and their data may be incorporated in the AQMA analysis study when it becomes available.

Applying the growth factors, the resultant emissions are as follows:

<u>Projected Emissions (tons/year)</u>									
	<u>Campbell</u>			<u>Converse</u>			<u>Sweetwater</u>		
	GF	PART	HC	GF	PART	HC	GF	PART	SO ₂
Commercial-Institutional									
1975	1.39	15	3	1.06	7	1	1.12	26	76
1980	3.75	41	8	1.74	11	2	1.50	35	102
1985	4.98	54	11	1.97	13	3	1.60	38	108
Industrial									
1975	1.16	16	3	1.02	5	1	1.12	1	2
1980	2.83	39	8	1.41	7	1	1.50	1	3
1985	3.57	49	10	1.56	8	2	1.60	1	3
Total (residential included)									
1975		31	6		12	2		27	78
1980		80	16		18	3		36	105
1985		103	21		21	5		39	111

GF = growth factor

3. RESIDUAL OIL

Data Inventory and Methodology

Residual oil consumption was determined by one method, apportioning state residual oil totals for commercial and industrial usage. It was assumed that there is no residential usage of residual oil in Wyoming, so only commercial and industrial residual oil consumption was calculated.

Commercial-Institutional:

Commercial-institutional residual oil consumption was calculated by apportioning state commercial-institutional residual oil by county/state population. State commercial-institutional consumption for area sources was determined from 1973 published data (Ref. 6), where 1973 data was assumed to be representative of 1974. Point source contribution for commercial-institutional fuel usage was assumed to be negligible.

State residual type heating oil (Ref. 6)	318,000 bbls = $13,356 \cdot 10^3$ gals
State residual used by military	--
1974 state commercial-residual oil consumption (10 ³ gallons/year)	$13,356 \cdot 10^3$ gals

The following is the apportioned commercial-institutional residual oil consumption by county.

	<u>State</u>	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
1974 population (Ref. 3)	359,000	11,900	7,100	25,900
1974 commercial-institutional residual oil consumption (10 ³ gals/year)	13,356	443	264	964

Distributors for commercial residual oil usage were not contacted, so calculated consumption was used.

Industrial:

Industrial residual oil consumption was calculated by apportioning state industrial residual oil consumption by mining, contract construction, and manufacturing employees. State industrial residual oil consumption for point and area sources was determined from the following 1973 published data, where 1973 data was assumed to be representative of 1974.

State industrial use (Ref. 6)	301,000 bbls = $12,642 \cdot 10^3$ gals
State oil companies' use (Ref. 6)	639,000 bbls = $26,838 \cdot 10^3$ gals
1974 state point and area source industrial residual oil consumption(10^3 gals/yr)	$39,480 \cdot 10^3$ gals

The following is the apportioned industrial residual oil consumption by county, assuming the 1973 ratio of county/state employees is representative of 1974.

	<u>State</u>	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
Mining, construction, and manufacturing employees (Ref. 2)	27,986	1,430	512	4,435
1974 point and area source industrial residual oil consump- tion (10^3 gals)	39,480	2,017	722	6,256
1974 point source industrial residual oil consumption (10^3 gals)		<u>974</u>	<u>367</u>	<u>9,048</u>
1974 industrial residual oil consumption (10^3 gals/year)		1,043	355	(neg)

Since the Sweetwater point source residual oil consumption is greater than the calculated point and area source total, the industrial residual oil consumption for Sweetwater County was assumed to be negligible.

Commercial-Institutional, Industrial:

The following is the total residual oil consumption in 1974 used to calculate emissions.

1974 Area Source Residual Oil Consumption (gals/yr)

Campbell	-	1,486,000
Converse	-	619,000
Sweetwater	-	964,000

Base Year Emissions

The emission factors for residual oil combustion are as follows (Ref. 12):

Emission Factors (lb/10³ gals)

Particulate	-	23
Hydrocarbon	-	3
Sulfur Oxides (SO ₂)	-	188.4 (1.2% sulfur) (Ref. 41)

Applying these emission factors to the county residual oil consumption yields the following emissions:

1974 Emissions (tons/year)

Campbell:	Particulate	-	17
	Hydrocarbon	-	2
Converse:	Particulate	-	7
	Hydrocarbon	-	1
Sweetwater:	Particulate	-	11
	SO ₂	-	91

Projections

The same procedure used in projecting distillate fuel oil was used for residual fuel oil. The resultant emissions are as follows:

<u>Projected Emissions. (tons/year)</u>									
	<u>Campbell</u>			<u>Converse</u>			<u>Sweetwater</u>		
	GF	PART	HC	GF	PART	HC	GF	PART	SO ₂
<u>Commercial-Institutional</u>									
1975	1.39	7	1	1.06	3	--	1.12	12	102
1980	3.75	19	3	1.74	5	1	1.50	17	137
1985	4.98	25	3	1.97	6	1	1.60	18	146
<u>Industrial</u>									
1975	1.16	14	2	1.02	4	--	1.12	--	--
1980	2.87	34	4	1.41	6	1	1.50	--	--
1985	3.57	43	6	1.56	6	1	1.60	--	--
<u>Total</u>									
1975		21	3		7			12	102
1980		53	7		11	2		17	137
1985		68	9		12	2		18	146

4. NATURAL GAS

Data Inventory and Methodology

The consumption of natural gas in the three counties was best determined by contact with the natural gas distributors. The total 1974 residential, commercial-institutional, and industrial natural gas sales for Campbell County was 1621 MMCF (Ref. 43). Since there was no point source consumption of natural gas, this value was used to calculate area source emissions.

The total 1974 residential, commercial-institutional, and industrial natural gas sales for Converse County was 730 MMCF (Ref. 43 and 44). The total 1974 point source natural gas consumption of 32 MMCF in Converse County (Ref. 41) was subtracted to obtain area source consumption. This value is 698 MMCF.

The total 1974 residential, commercial-institutional, and industrial natural gas sales for Sweetwater County were 16,080 MMCF (Ref. 45). The total 1974 point source industrial natural gas consumption of 7704 MMCF in Sweetwater County (Ref. 41) was subtracted to obtain the total area source consumption. This value is 8376 MMCF.

Base Year Emissions

The emission factors for natural gas combustion are (Ref. 12):

Emission Factors (lb/MMCF)

Particulate - 10

Hydrocarbon - 8

SO₂ - 0.6

Applying these factors to the county natural gas consumption yields the following emissions:

1974 Emissions (tons/year)

Campbell:	Particulates	-	8.1
	Hydrocarbons	-	6.5
Converse:	Particulates	-	3.5
	Hydrocarbons	-	2.8
Sweetwater:	Particulates	-	41.9
	SO ₂	-	2.5

Projections

Since the natural gas distributors did not have projections of natural gas consumption and they did not provide a breakdown by residential, commercial, and industrial, future consumption was paralleled with population growth. For Campbell and Converse Counties, DEPAD data was used (Ref. 56). For Sweetwater County, the Wyoming Department of Transportation planning projections were used (Ref. 57).

	<u>Projected Emissions (tons/year)</u>								
	<u>Campbell</u>			<u>Converse</u>			<u>Sweetwater</u>		
	GF	PART	HC	GF	PART	HC	GF	PART	SO ₂
1975	1.21	10	8	1.03	4	3	1.12	47	3
1980	2.45	20	16	1.44	5	4	1.50	63	4
1985	3.14	25	20	1.51	5	4	1.60	67	4

5. OTHER FUELS

Data Inventory and Methodology

Two types of other fuels were considered in this area source category: wood and LPG (liquified petroleum gas). The procedure used to determine consumption for each fuel type is discussed below.

(1) Wood

Residential wood consumption was calculated using the degree-day heating method (Ref. 11). The heating requirement factor used for the tons of wood burned per dwelling unit per degree-day is 0.0017 (Ref. 11). The number of dwelling units and degree-days for each county used to calculate wood consumption is as follows:

	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
1970 Dwelling units using wood (Ref. 1)	0	24	25
1974 Dwelling units using wood (assumed same as 1970)	0	24	25
Average rooms per dwelling unit (Ref. 1)	4.5	4.8	4.4
Average annual 1974 heating degree-days (Ref. 8)	7332 (Sheridan)	7584 (Casper)	7721 (Lander)
Residential wood consumption for 1974 (tons/year)	0	297	289

There were no data available to indicate that wood was consumed by commercial-institutional or industrial area sources. Therefore, both were considered to be negligible in this inventory.

(2) LPG

The combined 1973 State commercial and residential LPG consumption is 53,467,000 gallons (Ref. 7). It was assumed

that the 1973 consumption is representative of 1974. In order to disaggregate the state total into residential and commercial, the natural gas residential to commercial ratio (Ref. 5) was used. This ratio is 13,868/12,348. Therefore, the 1974 residential LPG consumption is approximately 28,000,000 gallons and the 1974 commercial LPG consumption is approximately 25,000,000 gallons.

Residential:

Residential LPG consumption was calculated by apportioning the state LPG consumption by number of dwelling units using LPG.

	<u>State</u>	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
1970 Dwelling units using LPG (Ref. 1)	13,474	1205	332	294
Growth factor	1.08	1.40	1.00	2.34
1974 Dwelling units using LPG	14,570	1687	332	688
1974 Residential LPG consumption (10 ³ gallons/year)	28,000	3506	690	1322

The increases in LPG usage from 1970 to 1974 (growth factor) were estimated by LPG distributors (Ref. 35 and 36). State LPG sales were assumed to increase in proportion to state population.

One major distributor for the three counties was contacted to obtain residential LPG sales for 1974. Sales for Converse were 673,652 gallons and for Sweetwater were 640,611 gallons (Ref. 36). Converse sales closely match the calculated consumption. Sweetwater sales are below the calculated since other major distributors were not included. The calculated residential LPG consumption was used to estimate emissions.

Commercial-Institutional:

Commercial-institutional LPG consumption was calculated by apportioning the state commercial LPG consumption by county/state population.

	<u>State</u>	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
1974 Population (Ref. 3)	359,000	11,900	7,100	25,900
1974 Commercial- institutional LPG consumption (10 ³ gallons/year)	25,000	829	494	1,803

Industrial:

Industrial LPG consumption was calculated by apportioning state industrial LPG consumption by county/state mining, contract construction, and manufacturing employees. The state industrial LPG consumption for 1973 was 10,276,000 gallons (Ref. 7) and was assumed to be representative of 1974. Also, the 1973 ratio of the county to state total employees in mining, construction, and manufacturing was assumed to be the same as for 1974.

The following is the apportioned industrial LPG consumption by county.

	<u>State</u>	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
Mining, construc- tion, and manufac- turing employees (Ref. 2)	27,986	1,430	512	4,435
1974 Industrial LPG consumption (10 ³ gallons/year)	10,276	525	188	1,628

Residential, Commercial, Institutional, Industrial:

The total estimated LPG consumption for 1974 for each county is as follows:

1974 Area Source LPG Consumption (gals/yr)

Campbell - 4,860,000
Converse - 1,372,000
Sweetwater - 4,753,000

Base Year Emissions

Emissions were calculated for the two types of fuels--wood and LPG.

(1) Wood

The average emission factors for wood burning in boilers are (Ref. 12):

Emission Factors (lb/ton)

Particulate - 10
Hydrocarbon - 36
Sulfur Oxides (SO₂) - 1.5

Applying these factors to the county wood consumption yields the following emissions:

1974 Wood Emissions (tons/yr)

Converse:	Particulate - 1.5
	Hydrocarbon - 5.3
Sweetwater:	Particulate - 1.4
	Sulfur Oxides (SO ₂) - 0.2

(2) LPG

The emission factors for LPG combustion are (Ref. 12):

Emission Factors (lb/10³ gals)

Particulate - 1.9
Hydrocarbon - 0.8
Sulfur Oxides (SO₂) - 0.9 (10 grains/100 ft³)

Applying these factors to the county total LPG consumption yields the following emissions:

1974 LPG Emissions (tons/year)

Campbell: Particulate - 4.6
 Hydrocarbon - 1.9
Converse: Particulate - 1.3
 Hydrocarbon - 0.5
Sweetwater: Particulate - 4.5
 SO₂ - 2.1

Projections

Projected emissions for wood were calculated by applying population growth factors. Since wood burning exists only in the residential sector, population would be an acceptable measure of growth in consumption.

Projected Wood Emissions (tons/year)

	<u>Converse</u>			<u>Sweetwater</u>		
	GF	PART	HC	GF	PART	SO ₂
1975	1.03	2	5	1.12	2	--
1980	1.44	2	8	1.50	2	--
1985	1.51	2	8	1.60	2	--

Since base year LPG emissions are small, applying separate growth factors to residential, commercial, and industrial categories is not necessary. Therefore, population growth factors were considered adequate and resulted in the following projected emissions:

Projected LPG Emissions (tons/year)

	<u>Campbell</u>			<u>Converse</u>			<u>Sweetwater</u>		
	GF	PART	HC	GF	PART	HC	GF	PART	SO ₂
1975	1.21	6	2	1.03	1	1	1.12	5	2
1980	2.45	11	5	1.44	2	1	1.50	7	3
1985	3.14	14	6	1.51	2	1	1.60	7	3

6. OPEN BURNING

Data Inventory and Methodology

There are four classifications of open burning which have been used in estimating emissions: (1) oil sump burning; (2) agricultural burning; (3) slash burning, and (4) forest fires. Oil sump burning is the ignition of oil that has accumulated in a pit, pond, or creek from small oil spills, transmission pipeline leaks, or tank overflows. Also included in this classification are oil well testing and oil tank battery fires. Agricultural burning includes all intentional field burning done by farmers and ranchers. Slash burning includes waste from logging operations and brush from land clearing. Forest fires are self-explanatory. Data for each classification is as follows:

(1) Oil Burning

The following is a summary of the number of barrels of crude oil burned in each county for the year 1974 (Ref.9):

Campbell:	2308 bbls = 96,936 gals
Converse:	8210 bbls = 344,820 gals
Sweetwater:	316 bbls = 13,272 gals

This data was extracted from the Open Burning Log in the Wyoming Air Quality Division files and multiplied by a factor of 2 to reflect unreported oil burning in a sump. Ten barrels of oil burned was assumed if the number of gallons burned was not recorded in the Log. The range of the number of barrels burned per site was from 2 to 200 barrels, with the average being approximately 25 barrels. Also included in the open burning log was natural gas flaring, which was neglected as a source classification due to the short periods of burning (one day to two weeks) and the uncertainty of the amount burned.

(2) Agricultural Burning

The Wyoming Department of Agriculture was contacted to determine the number of acres and tons per acre of stubble burned. It was the opinion of the department that the number of acres burned was very small and should be neglected as a pollutant source. The Wyoming AQD concurred.

(3) Slash Burning

The Open Burning Log is also used to record slash burning requests by the U.S. Forest Service or private companies. There were no slash burning requests in the three counties for the calendar year 1974.

(4) Forest Fires

The U.S. Forest Service, Rocky Mountain Regional Office, was contacted to obtain data on the number, location, and acres of forest fires that occurred in 1974 (Ref. 10). Only one forest, Medicine Bow, exists in the three counties. It covers the southwestern portion of Converse County. Two fires were identified occurring in July and August which burned a total of 6 non-commercial forest acres. The area is moderately forested, so it was assumed that 30 tons/acre of vegetation were burned (Ref. 11). This yields a total of 180 tons of vegetation burned during 1974.

Base Year Emissions

There are only two open burning classifications with emissions during 1974: forest fires and oil burning. The emission factors for open wood burning are 17 lb/ton for particulate and 4 lb/ton for hydrocarbon. The emissions in 1974 from forest fires are:

1974 Forest Fire Emissions (tons/year)

	<u>Particulates</u>	<u>HC</u>
Converse	1.5	0.4

Since there is no particulate emission factor for oil sump burning, the following procedure was used to derive an emission factor. The EPA published particulate emission factors for orchard heaters (smudge pots) were reviewed. The factors for each smudge pot type (Ref. 12) are:

lazyflame - .094 lb/6 lb	= 15.7 lb/1000 lb
	= 113 lb/1000 gals
cone type - .088 lb/8 lb	= 11.1 lb/1000 lb
	= 80 lb/1000 gals
return stack - .098 lb/11 lb	= 8.9 lb/1000 lb
	= 54 lb/1000 gals

The average emission factor for orchard heaters is 82 lb/1000 gals.

The particulate emission factor for residual oil in a boiler is 23 lb/1000 gals. These published factors were compared to an unpublished emission factor for particulates developed from the burning of kerosene and gasoline used in fire drills performed by the Navy. This factor is 943 lb/1000 gal (Ref. 13) and is considerably higher than the others due to the low burning temperature and incomplete combustion caused by water spray. It is estimated that oil sump burning would have a higher emission factor than controlled combustion in a boiler, but be lower than the fire drill oil burning. Therefore, an average of the three emission factors is proposed as the emission factor for oil sump burning--350 lb/1000 gals.

The combustion emission factor for hydrocarbons is negligible, since nearly all of the hydrocarbon losses are evaporative (Ref. 12).

The emission factor for sulfur oxides is $15.7 \text{ lb}/10^3 \text{ gallons}$ (Ref. 12), which is based on 0.1 percent sulfur in crude oil in Sweetwater County (Ref. 17).

Applying these emission factors to the oil burned in each county yields the following emissions:

1974 Oil Burning Emissions (tons/year)

Campbell:	Particulates - 17
Converse:	Particulates - 60
Sweetwater:	Particulates - 2.6
	SO ₂ - negligible

Projections

Since forest fires vary from year to year, it is impossible to predict emissions for future years. It was assumed that these emissions remain the same for 1975, 1980, and 1985, since only a small portion of Converse County has a forested area and base year emissions are small.

It is also difficult to predict future oil spills and pipeline leaks. Short term (1974-78) oil and gas production projections made by DEPAD are shown to be constant (Ref. 58). Therefore, it is assumed that oil sump burning will remain the same for 1975, 1980, and 1985.

7. HIGHWAY VEHICLES

Data Inventory and Methodology

The Wyoming State Highway Department was contacted to obtain traffic data (Ref. 14). Total daily VMT (vehicle-miles of travel) data for 1974 were obtained for the following highway system categories: Interstate, Federal Aid Primary (FAP), Federal Aid Secondary (FAS); and State Highway System. Three other categories exist in Wyoming: Federal Aid Primary not on system; County; and City Streets. Data for these other categories were obtained from unpublished data for the year 1973 provided by the Highway Department. This analysis assumes that 1973 VMT data for the three categories are also representative of 1974. The following is a summary of the data:

1974 Daily VMT

	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
Interstate	110,626	168,641	770,923
FAP	144,037	84,448	113,863
FAS	29,990	17,713	83,519
State Highway	--	102	--
FAS not on System	--	1,933	14,388
County	48,991	29,223	77,173
City Streets	8,884	8,540	53,653
Total Annual VMT	125,022,720	113,369,000	406,434,435

Since HC emissions are a function of vehicle speed, it is necessary to apply an emission correction factor based on speeds assigned to each highway system category. The Highway Department provided the following average speeds for the category groupings:

<u>Category</u>	<u>Speed</u>	<u>HC Speed Correction Factor</u>
Freeway - Interstate	55 MPH	.63
FAP		
Arterial - FAS	45 MPH	.63
State Highway		
FAS not on system		
County		
Local - City Streets	25 MPH	.86

In order to disaggregate total VMT into travel by light-duty vehicles (LDV), heavy-duty vehicles (HDV), and heavy-duty diesel (HDD), the Wyoming Department of Revenue was contacted to obtain the percent of commercial vehicles registered in 1974 by weight and by fuel use (Ref. 15). The following data were provided for all interstate and intrastate commercial vehicles registered:

Commercial Vehicles

<u>No. of Vehicles</u>	<u>Fuel Type</u>	<u>No. of Vehicles</u>	<u>Gross Veh. Weight</u>
30,376	gasoline	27,435 (30%)	<16,000 lbs.
60,135	diesel	63,704 (70%)	>16,000 lbs.
616	LPG		
12	other		

The percentages of commercial vehicles less than 8,500 lb. gross weight (LDT) and greater than 8,500 lb. (HDV) could not be determined from any summaries of registration records. It was assumed that half of the commercial vehicles less than 16,000 lbs. are LDT. This assumption seems reasonable because of the large number of pick-up trucks registered as commercial vehicles.

To account for commercial vehicles that are actually light-duty vehicles, 15% of the commercial vehicle VMT in each

county were subtracted to get HDV VMT, and the same amount was added to LDT VMT. Also, the percent of vehicles greater than 8,500 lbs. using gasoline and diesel were adjusted to reflect the 15% reduction in HDV VMT. This adjustment shows that 19% of the heavy-duty commercial are gasoline fueled and 81% are diesel fueled.

The 15% reduction was applied to commercial VMT data provided by the Highway Dept. for Interstate, FAP, FAS, and State Highways (Ref. 14). The total VMT for the remaining three categories were factored as follows:

- FAS not on system - Ratio of commercial to total VMT for FAS
- County - Ratio of commercial to total VMT for State Highways
- City Streets - Assumed to be 3%

The reduced commercial VMT and factored total VMT produces heavy-duty VMT estimates for both gasoline and diesel vehicles:

Heavy-Duty VMT

	<u>Campbell</u>		<u>Converse</u>		<u>Sweetwater</u>	
	<u>VMT</u>	<u>% Total</u>	<u>VMT</u>	<u>% Total</u>	<u>VMT</u>	<u>% Total</u>
Interstate	15,064	13.6	21,785	13.0	196,015	25.0
FAP	20,635	14.3	9,184	10.8	14,614	12.8
FAS	4,989	16.6	1,763	10.0	10,901	13.0
State Highway	--	--	8	8.0	--	--
FAS not on system	--	--	193	10.0	1,870	13.0
County	3,919	8.0	2,337	8.0	6,174	8.0
City Streets	266	3.0	256	3.0	1,609	3.0

The heavy-duty VMT estimates were subtracted from the total VMT to obtain the total light-duty VMT.

Light-Duty VMT

	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
Interstate	95,562	146,856	574,908
FAP	123,402	75,264	99,249
FAS	25,001	15,950	72,618
State Highway	--	94	--
FAS not on system	--	1,740	12,518
County	45,072	26,886	70,999
City Streets	8,618	8,284	52,044

In order to further disaggregate the heavy-duty VMT into HDV (using gasoline) and HDD (using diesel) the 19% and 81% factors were applied to the heavy-duty VMT values shown above.

Heavy Duty VMT
For Gasoline & Diesel

	<u>Campbell</u>		<u>Converse</u>		<u>Sweetwater</u>	
	<u>Gas</u>	<u>Diesel</u>	<u>Gas</u>	<u>Diesel</u>	<u>Gas</u>	<u>Diesel</u>
Interstate	2,862	12,201	4,139	17,645	37,243	158,772
FAP	3,920	16,714	1,745	7,439	2,777	11,837
FAS	948	4,041	335	1,428	2,071	8,830
State Highway	--	--	2	6	--	--
FAS not on system	--	--	37	156	355	1,515
County	745	3,174	444	1,893	1,173	5,001
City Streets	50	216	49	207	306	1,303

Prior to applying appropriate emission factors and speed correction factors, the LDV, LDT, HDV, and HDD daily VMT were grouped according to freeway, arterial, or local traffic and converted to annual VMT, as shown below.

1974 Annual VMT x 10³

	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
LDV			
Freeway	77,623	79,079	235,863
Arterial	25,003	16,027	55,769
Local	<u>3,129</u>	<u>3,007</u>	<u>18,892</u>
	105,755	98,113	310,524
LDT			
Freeway	2,299	1,995	10,204
Arterial	574	277	1,220
Local	<u>17</u>	<u>16</u>	<u>104</u>
	2,890	2,288	11,528
HDV			
Freeway	10,554	9,156	62,272
Arterial	2,633	1,271	5,601
Local	<u>79</u>	<u>76</u>	<u>476</u>
	13,266	10,503	68,349
HDD			
Freeway	2,475	2,148	14,607
Arterial	618	299	1,314
Local	<u>18</u>	<u>18</u>	<u>112</u>
	3,111	2,465	16,033
Total	125,022	113,369	406,434

To check the annual VMT, gasoline sales totals for each county were obtained from the State Department of Revenue for 1974. Diesel sales could not be obtained because there is no diesel sales tax in Wyoming. Total VMT calculated by applying an average vehicle mileage factor of 12.2 miles per gallon (Ref. 11) to the county gasoline sales are as follows:

	<u>Gasoline Sales VMT</u>	<u>LDV, LDT & HDV VMT</u>
Campbell	138,645,509	121,911,000
Converse	72,318,513	110,904,000
Sweetwater	366,949,953	390,401,000

Considering the relative accuracy of the 12.2 miles per gallon average mileage factor, reasonably good agreement was found between VMT estimates from the Highway Department and VMT

Hydrocarbon emission factors for the year 1974 were calculated for the four vehicle classes by procedures described in Supplement 5 to AP-42 (August 1975) (Ref. 12). These emission factors are a function of vehicle age distribution, ambient temperature, percent of vehicles operating with a cold engine, altitude, and average vehicle speed. The following assumptions were made with respect to the above variables:

- . the fraction of travel by each model year is the same in Wyoming as nationwide
- . mean annual temperature = 45° F
- . approximately 20 percent of the LDV are operating in a cold condition (first 500 seconds of operation after an engine-off period of at least 4 hours) at any given time
- . high altitude emission rates are applicable.

The resulting emission factors for each of the four vehicle classes and three highway types are summarized below. The annual HC emissions for Campbell and Converse Counties are also presented in that summary. The emission estimates were determined by multiplying annual VMT for each travel category by the corresponding emission factor.

Vehicle Class	Highway Type	HC Emission Factor, gm/VMT	Hydrocarbon Emissions (tons/yr)	
			Campbell	Converse
LDV	Freeway	8.75	749	763
	Arterial	8.75	241	155
	Local	10.96	38	36
LDT	Freeway	11.57	29	25
	Arterial	11.57	7	4
	Local	14.00	-	-
HDV	Freeway	25.83	300	261
	Arterial	25.83	75	36
	Local	31.50	3	3
HDD	Freeway	2.34	6	6
	Arterial	2.59	2	1
	Local	3.66	-	-
Total			1450	1290

computed from gasoline sales. Since the Highway Department VMT is based on counts of actual traffic volume, these data were used to estimate emissions.

Base Year Emissions

Emission factors for LDV, LDT, HDV, and HDD for particulates and sulfur oxides are as follows (Ref. 12).

Emission Factors (gm/mile)

<u>Pollutant</u>	<u>LDV, LDT</u>	<u>HDV</u>	<u>HDD</u>
Particulate			
Exhaust	.34	.91	1.30
Tire wear	.20	.27	.27
Brake wear	<u>.02</u>	<u>.03</u>	<u>.03</u>
	.56	1.21	1.60
Sulfur Oxides			
(SO ₂)	.18	.36	2.8

Since only Sweetwater County has been designated for SO₂, sulfur dioxide emissions were not calculated for Converse and Campbell. County-wide emissions are calculated by multiplying VMT by the appropriate emission factor for LDV, LDT, HDV, and HDD.

1974 Particulate and SO₂ Emissions (tons/yr)

	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>	
	<u>Particulates</u>	<u>Particulates</u>	<u>Particulates</u>	<u>SO₂</u>
LDV, LDT	67.0	62.0	248.8	63.9
HDV	17.7	14.0	91.2	27.1
HDD	<u>5.5</u>	<u>4.3</u>	<u>28.2</u>	<u>49.5</u>
Total	90.2	80.3	368.2	140.5

Projections

According to Supplement 5 of EPA's Compilation of Emission Factors (August 1975), SO₂ emission factors will remain the same for future model years. Therefore, projected SO₂ emissions will vary only with VMT.

However, particulate emission factors will decrease for future model years due to the use of unleaded fuel. It is assumed that all model year vehicles beyond 1975 will use unleaded fuel. Therefore, projected particulate emissions will vary with model year and VMT.

Since projected VMT for the three counties was not available from the highway department, alternative methods were examined. The selected method was to assume that foreign (out-of-state) travel will remain constant and that the remainder of the VMT (Wyoming) will increase with county population.

The percent of foreign vehicles was available for two highway system types: freeway and arterial. These percentages for interstate and primary and secondary roads by county are as follows (Ref. 14).

	<u>Percent Foreign Vehicles</u>		
	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
Freeway (Interstate)	.34	.27	.47
Arterial (FAP and FAS)	.07	.09	.26

It was assumed that there are no foreign vehicles on local roads.

Base year VMT was then converted to percentages according to three categories:

Percent of VMT

	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
Freeway	.74	.81	.83
Arterial	.23	.16	.13
Local	.03	.03	.04

Total base year emissions for each county were subdivided into the three categories using the above percentages.

Base Year Total Emissions (tons/year)

	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>	
	PART	PART	PART	SO ₂
Freeway	67	65	305	118
Arterial	21	13	48	19
Local	<u>2</u>	<u>2</u>	<u>15</u>	<u>4</u>
Total	90	80	368	141

This method assumes that the ratio of LDV, LDT, HDV, and HDD will remain the same in future years. These emissions were multiplied by the percent of in-state vehicles to obtain those emissions from in-state traffic.

Base Year In-State Traffic Emissions (tons/year)

	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>	
	PART	PART	PART	SO ₂
Freeway	44	47	162	63
Arterial	20	12	36	14
Local	<u>2</u>	<u>2</u>	<u>14</u>	<u>4</u>
Total	66	61	212	81

These emissions were then multiplied by population growth factors and added to emissions from foreign traffic.

Particulate emissions were adjusted for those vehicles using unleaded fuel. The emission factor for unleaded fuel for LDV and LDT is .05 gm/mile (Supplement 5, AP-42). The ratio of LDV and LDT VMT to total VMT was calculated for each

county and multiplied by the 1980 and 1985 total emissions to obtain the emissions from LDV and LDT vehicle types. Only the emissions from these vehicle types will be affected by the use of unleaded gas.

An average particulate emission factor for 1980 and 1985 was calculated with 60 percent and 93 percent of all vehicles using unleaded fuel by 1980 and 1985, respectively.

For 1980,

$$EF = (.4) (.34) + (.6) (.05) + (.22) = .39 \text{ gm/mi.}$$

For 1985,

$$EF = (.07) (.34) + (.93) (.05) + (.22) = .29 \text{ gm/mi.}$$

where, EF = emission factor

The percent vehicles using unleaded fuel (beyond 1975) was obtained from the national vehicle age population distribution. The ratio of the average emission factor to the 1974 emission factor (.56 gm/mile) was calculated and multiplied by the emissions from LDV and LDT to determine the 1980 and 1985 loss in emissions from unleaded fuel use. This loss was subtracted from the 1980 and 1985 projected emissions, therefore adjusting emissions for those vehicles using unleaded fuel.

<u>Projected Emissions (tons/year)</u>								
<u>Campbell</u>			<u>Converse</u>		<u>Sweetwater</u>			
	GF	PART	GF	PART	GF	PART	SO ₂	
In-State Traffic								
1975	1.21	80	1.03	63	1.12	237	91	
1980	2.45	126	1.44	68	1.50	254	105	
1985	3.14	133	1.51	58	1.60	229	102	
Foreign Traffic								
1975	1.0	24	1.0	19	1.0	156	60	

1980	1.0	19	1.0	15	1.0	125	79
1985	1.0	15	1.0	12	1.0	106	74
Total							
1975		104		82		393	151
1980		145		83		379	184
1985		148		70		335	176

Since hydrocarbon emission factors vary with each vehicle model year, Supplement 5 of EPA's Compilation of Emission Factors (August 1975) was used to calculate these factors for future years. Therefore, projected HC emissions vary with both VMT and emission factors.

The method used to project VMT in estimating projected particulate and SO₂ emissions was also used for hydrocarbon emissions. Projected VMT for each vehicle class and highway type is shown in Table 7.1.

Projected emission factors for each vehicle class and highway type are as follows:

<u>Vehicle Class</u>	<u>Highway Type</u>	<u>HC Emission Factor</u> <u>(gm/VMT)</u>		
		1975	1980	1985
LDV	Freeway	8.3	5.5	2.1
	Arterial	8.3	5.5	2.1
	Local	10.4	6.8	2.5
LDT	Freeway	11.0	8.2	4.0
	Arterial	11.0	8.2	4.0
	Local	13.3	9.8	4.9
HDV	Freeway	24.1	18.0	13.2
	Arterial	24.1	18.0	13.2
	Local	29.3	21.5	15.4
HDD	Freeway	2.3	2.3	2.3
	Arterial	2.6	2.6	2.6
	Local	3.7	3.7	3.7

Applying these factors to projected VMT for Campbell and Converse Counties results in the following projected emissions:

Table 7.1. Projected Annual VMT (10³)

	Campbell			Converse			Sweetwater		
	1975	1980	1985	1975	1980	1985	1975	1980	1985
LDV									
Freeway	89,266	160,679	201,043	80,661	105,966	109,920	252,373	304,263	318,415
Arterial	28,753	51,756	64,758	16,347	21,476	22,278	59,673	71,942	75,288
Local	3,598	6,477	8,104	3,067	4,029	4,180	20,214	24,371	25,504
LDT									
Freeway	2,644	4,759	5,954	2,035	2,673	2,773	10,918	13,163	13,775
Arterial	660	1,188	1,487	282	371	385	1,305	1,574	1,647
Local	20	35	44	16	21	22	111	134	140
HDV									
Freeway	12,137	21,846	27,335	9,339	12,269	12,727	66,631	80,331	84,067
Arterial	3,028	5,450	6,819	1,296	1,703	1,767	5,993	7,225	7,561
Local	91	163	205	78	102	106	509	614	643
HDD									
Freeway	2,846	5,123	6,410	2,191	2,878	2,986	15,629	18,843	19,719
Arterial	711	1,279	1,601	305	401	416	1,406	1,695	1,774
Local	21	37	47	18	24	25	120	144	151

Projected Hydrocarbon Emissions (tons/year)

	<u>Campbell</u>			<u>Converse</u>		
	1975	1980	1985	1975	1980	1985
LDV						
Freeway	817	974	465	738	642	254
Arterial	263	314	150	150	130	51
Local	41	49	22	35	30	11
LDT						
Freeway	32	43	26	25	24	12
Arterial	8	11	7	3	3	2
Local	--	--	--	--	--	--
HDV						
Freeway	322	433	398	248	243	185
Arterial	80	108	99	34	34	26
Local	3	4	4	3	2	2
HDD						
Freeway	7	13	16	6	7	8
Arterial	2	4	5	1	1	1
Local	--	--	--	--	--	--
Total	1575	1953	1192	1243	1116	552

8. OFF-HIGHWAY VEHICLES

Data Inventory and Methodology

This category includes off-highway sources using: (1) gasoline; (2) diesel. Typical gasoline fuel users are farm tractors, construction tractors, compressors, pumps, and small electric generators. Typical diesel fuel users are farm tractors, construction tractors, and construction loaders and grader

(1) Gasoline

To calculate gasoline fuel consumption two fuel usage factors were used (Ref. 11):

tractor gasoline - 1,000 gals/tractor/year
fuel usage factor
population gasoline - 13 gals/person/year
fuel usage factor

The total number of farm tractors (Ref. 16) and population (Ref. 3) in each county is as follows:

	<u>Tractors</u>		<u>1974 Population</u>
	<u>1969</u>	<u>1974</u>	
Campbell:	885	956	11,900
Converse:	648	700	7,100
Sweetwater:	276	298	25,900

It is assumed that the number of tractors has increased from 1969 to 1974 by 8%, which is proportional to state wide population growth.

Applying the tractor fuel usage factor to the number of tractors in each county and assuming that 60% are gasoline powered (Ref. 11), yields the gasoline consumption by tractors.

Tractor Gasoline Consumption (gals/yr)

Campbell - 573,600
Converse - 420,000
Sweetwater - 178,800

Applying the population fuel usage factor to population in each county, yields the gasoline consumption by other fuel users.

Other Gasoline Consumption (gals/yr)

Campbell - 154,700
Converse - 92,300
Sweetwater - 336,700

(2) Diesel

To calculate diesel fuel consumption two fuel usage factors were used (Ref. 11).

tractor diesel - 1,000 gals/tractor/year
fuel usage factor
construction diesel - 5,000 gals/employee/year
fuel usage factor

The total number of non-building construction employees in 1973 (Ref. 2) in each county is as follows:

Non-Building Employees

Campbell - 108
Converse - 140
Sweetwater - 400

Employees for 1973 are assumed to be representative of 1974.

Applying the tractor fuel usage factor to the number of tractors in each county and assuming that 35% are diesel powered (Ref. 11), yields the diesel consumption by tractors:

Tractor Diesel Consumption (gals/year)

Campbell - 334,600
Converse - 245,000
Sweetwater - 104,300

Applying the construction fuel usage factor to number of non-building employees, yields the diesel consumption by other diesel fuel users.

Other Diesel Consumption (gals/year)

Campbell - 540,000
Converse - 700,000
Sweetwater - 2,000,000

Base Year Emissions

Emission factors for gasoline and diesel farm tractors are as follows (Ref. 12):

Tractor Emission Factors (lb/10³ gal)

	<u>Gasoline</u>	<u>Diesel</u>
Particulate	8.0	45.7
Exhaust HC	125.0	60.7
Crankcase HC	25.1	-
SO ₂	5.3	31.2

Emission factors for other fuel consumption were obtained by averaging gasoline and diesel-powered construction equipment emission factors (Ref. 12).

Other Fuel Consumption Emission Factors (lb/10³ gals)

	<u>Gasoline</u>	<u>Diesel</u>
Particulate	7.1	26.1
Exhaust HC	136.8	29.1
SO ₂	5.3	31.2

Applying these emission factors to the tractor and other fuel consumption for both gasoline and diesel yields the following emissions:

1974 Emissions (tons/year)

	<u>Campbell</u>		<u>Converse</u>		<u>Sweetwater</u>	
	Part	HC	Part	HC	Part	SO ₂
Tractor						
Gas	2	43	2	32	1	-
Diesel	8	10	6	7	2	2
Other						
Gas	1	11	-	6	1	1
Diesel	7	8	9	10	26	31
Total	18	72	17	55	30	34

Projections

Since off-highway base year emissions were determined by applying fuel usage factors for tractors, population, and construction employees, growth in emissions would parallel projected farm activity, population, and construction. Farming activity will remain relatively constant in the three counties (growth factor = 1.0), while population and construction will both increase.

Construction growth factors were obtained from DEPAD (Ref. 56) for Campbell and Converse Counties. Construction data were not available for Sweetwater County, so population growth factors were used.

<u>Projected Emissions (tons/year)</u>									
	<u>Campbell</u>			<u>Converse</u>			<u>Sweetwater</u>		
	GF	PART	HC	GF	PART	HC	GF	PART	SO ₂
Other Gasoline (assumed to increase in proportion to population)									
1975	1.21	1	13	1.03	--	6	1.12	1	--
1980	2.45	2	27	1.44	1	9	1.50	2	1
1985	3.14	3	35	1.51	1	9	1.60	2	1
Other Diesel (assumed to increase in proportion to construction activity)									
1975	2.97	21	24	1.25	11	13	1.12	29	35
1980	4.14	29	33	2.45	22	25	1.50	39	47
1985	4.64	32	37	1.20	10	12	1.60	42	50
Tractor (assumed constant)									
1975	1.0	10	53	1.0	8	39	1.0	3	2
1980	1.0	10	53	1.0	8	39	1.0	3	2
1985	1.0	10	53	1.0	8	39	1.0	3	2
Total									
1975		32	90		19	58		33	37
1980		41	113		31	73		44	50
1985		45	125		19	60		47	53

9. RAILROADS

Data Inventory and Methodology

The Wyoming Air Quality Division contacted the Wyoming Public Service Commission to obtain data on miles of track for each railroad company in the three counties and in the entire state (Ref. 18). The following is a summary of the miles of track for each county for 1974:

	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
Burlington Northern	76	69	--
Chicago and Northwestern	--	70	--
Union Pacific	--	--	433
U.S. Steel Corp.	--	--	57
TOTAL	76	139	490

The total miles of track for all railroads in the state is 3287 miles. Miles of track include main line, second line, passing and switching, and yards (abandoned track has been subtracted).

The total state residual and distillate fuel oil consumed by railroad locomotives in 1973 was 2.552×10^6 barrels (Ref. 6). To calculate the 1974 railroad fuel consumption for each county, the 1974 statewide fuel consumption was assumed to be the same as 1973 and the miles of track were used to apportion fuel to each county. Therefore, using .023, .042, and .149 for Campbell, Converse, and Sweetwater counties, respectively, county railroad fuel consumption was calculated.

Campbell - $2,478 \cdot 10^3$ gals/yr.
Converse - $4,533 \cdot 10^3$ gals/yr.
Sweetwater - $15,975 \cdot 10^3$ gals/yr.

The apportioned fuel consumption was checked by contacting the Burlington Northern (BN), Chicago and Northwestern (CNW), and Union Pacific (UP). The CNW and BN provided information on frequency of trains, speeds, and average fuel consumption rate. The BN provided the following data for Converse and Campbell (Ref. 19):

	<u>Converse</u>	<u>Campbell</u>
trains/day	4.0	14.0
locomotive/train	3.0	4.0
fuel consumption	2½ gals/mi/loco.	2½ gals/mi/loco.
speed	49 MPH	49 MPH

The CNW provided the following data for Converse County (Ref. 20):

trains/day	1.0
fuel consumption	300 gal/hour
speed	45 MPH

The BN and CNW indicated that no trains operate on Sunday, therefore, trains operate 313 days/year. Using the track mileage reported above, the following fuel usage rates were calculated:

	<u>Converse</u>	<u>Campbell</u>
Burlington Northern	583 · 10 ³	2,997 · 10 ³
Chicago and Northwestern	146 · 10 ³	--
TOTAL	729 · 10 ³ gals/yr.	2,997 · 10 ³ gals/yr.

UP data for Sweetwater County could not be obtained within the time constraints of this analysis.

Since the actual fuel consumption is more accurate than apportioning statewide fuel consumption, the actual fuel totals were used for Campbell and Converse Counties. Apportioned fuel consumption was used for Sweetwater due to the lack of actual fuel data.

Base Year Emissions

The following are the emission factors used to calculate particulate, SO₂, and hydrocarbon emissions (Ref. 12):

Particulate - 25 lb/10³ gals
SO₂ - 57 lb/10³ gals (.4% sulfur)
HC - 94 lb/10³ gals

The calculated emissions and associated fuel consumptions are as follows:

	<u>1974 Emissions (tons/yr)</u>
Campbell:	Fuel Consumption - 2,997 · 10 ³ gals/yr
	Particulates - 37 tons/yr
	Hydrocarbons - 141 tons/yr
Converse:	Fuel Consumption - 729 · 10 ³ gals/yr
	Particulates - 9 tons/yr
	Hydrocarbons - 34 tons/yr
Sweetwater:	Fuel Consumption - 15,975 · 10 ³ gals/yr
	Particulates - 200 tons/yr
	SO ₂ - 455 tons/yr.

Projections

DEPAD reported that in the Powder River Basin, a transportation alternative for coal development is to transport coal out of Wyoming by rail (Ref. 60). This report stated that a 113 mile track connecting Gillette and Douglas could be completed in two years. It is assumed that this alternative will be selected since current plans call for six new coal mines with the three existing coal mines expanding their operation (Ref. 42). The only new coal users locally will be one coal gasification plant and expansion of the existing Wyodak power plant.

This new track will carry a maximum of 24 loaded trains per day (plus 24 empty) in 1980 and 34 loaded trains per day (plus 34 empty) in 1985. These train frequencies were obtained from the Powder River Basin EIS (Ref. 42).

The 1975 Campbell and Converse County railroad emissions were estimated to be the same as the 1974 emissions.

An average train will be powered by approximately 5 locomotives (Ref. 42). Trains will operate 365 days per year. It was assumed that half of the trains will service the coal mines through Gillette and the other half will service through Douglas. Burlington Northern average fuel consumption data (2.25 gals/loco./mile) were used to calculate future emissions. Existing train activity will probably continue at the same level to 1985 in these two counties.

In Sweetwater County only one new coal mine is known to be opening. Since most of this new coal will be used to supply the new units at the Jim Bridger Power Plant, an increase in railroad activity across the county is not expected. Therefore, railroad emissions will probably remain constant through 1980 and 1985.

Projected Emissions (tons/year)

	<u>Campbell</u>		<u>Converse</u>		<u>Sweetwater</u>	
	PART	HC	PART	HC	PART	SO ₂
1975	37	141	9	34	200	455
1980	176	664	148	558	200	455
1985	232	877	206	776	200	455

10. AIRCRAFT

Data Inventory and Methodology

Aircraft operations are limited to three general aviation airports located in Rock Springs, Gillette, and Douglas. Gillette and Douglas presently have no domestic air carrier service but are serviced by a third level or commuter air carrier (Ref. 21). The third level carrier operates approximately two flights per day into each airport. Rock Springs is serviced by a domestic carrier with six scheduled flights per day (Ref. 22). The remainder of the aircraft operations at the three airports is general aviation.

The type of aircraft used for the domestic carrier is Convair 580 turboprop. Third level carrier and general aviation are both comprised of general aviation piston aircraft.

Annual airport operations (landing and take-off) for each aircraft type and each airport in 1974 are summarized below:

<u>Aircraft(engines)</u>	<u>Rock Springs</u>	<u>Gillette</u>	<u>Douglas</u>
Air carrier turboprop (2)	2,200	--	--
Business jets (2)	1,000	Neg	Neg
General aviation turboprop (2)	3,000	Neg	Neg
General aviation piston			
2 engines	16,900	3,650	3,650
1 engine	16,900	3,650	3,650
TOTAL	40,000	7,300	7,300

Rock Spring's annual operations were provided by the Rock Springs Municipal Airport Manager (Ref 22). The Gillette and Douglas annual operations were determined by assuming

that each airport had an average daily operation of 20 aircraft (Ref. 23) and that the business jet and general aviation turboprop traffic was negligible. It was assumed that turboprop and business jets normally have two engines and that $\frac{1}{2}$ of the piston engine aircraft have 2 engines.

Base Year Emissions

The emission factors for a landing and takeoff cycle are as follows for each aircraft type (Ref. 12):

Emission factor (lb/engine)

	<u>Particulate</u>	<u>Hydrocarbon</u>	<u>SO₂</u>
Air carrier turboprop	1.1	2.9	.40
Business jet	.11	3.6	.37
General aviation turboprop	.20	1.1	.18
General aviation piston	.02	.40	.014

Multiplying the emission factor by the number of engines and annual LTO cycles yields the total emissions for each pollutant for the year 1974.

1974 Emissions (tons/yr)

	<u>Campbell (Gillette)</u>		<u>Converse (Douglas)</u>		<u>Sweetwater (Rk.Sp.)</u>	
	<u>Part</u>	<u>HC</u>	<u>Part</u>	<u>HC</u>	<u>Part</u>	<u>SO₂</u>
Air carrier turboprop	--	--	--	--	2.4	0.9
Business jets	--	--	--	--	0.1	0.4
General aviation turboprop	--	--	--	--	0.6	0.5
General aviation piston	0.1	2.2	0.1	2.2	0.5	0.4
TOTAL	0.1	2.2	0.1	2.2	3.6	2.2

Projections

Projections of activity at the Rock Springs airport were obtained from the Manager of the Rock Springs Municipal Airport (Ref. 22). It is anticipated that there will be a 60 percent increase in operations by 1985. This gives a growth factor of 1.3 from 1974 to 1980 and 1.60 from 1974 to 1985. It is assumed that operations will remain almost constant from 1974 to 1975.

For Campbell and Converse Counties, it is assumed the operations will remain the same in 1975 as in the base year and increase approximately 100 percent from 1975 to 1985 (Ref. 27). Detailed estimates are not warranted because of the negligible emissions from this source category. Growth factors from the base year and resultant emissions are as follows:

<u>Projected Emissions (tons/year)</u>									
	<u>Campbell</u>			<u>Converse</u>			<u>Sweetwater</u>		
	GF	PART	HC	GF	PART	HC	GF	PART	SO ₂
1975	--	.12	2.2	--	.12	2.2	--	3.6	2.2
1980	1.5	.18	3.3	1.5	.18	3.3	1.3	4.7	2.9
1985	2.0	.24	4.4	2.0	.24	4.4	1.6	5.8	3.5

11. INDUSTRIAL PROCESSES

Two categories of industrial processes have been considered as area sources: (1) heater treaters; (2) pipeline compressors. Each of the categories has been analyzed separately.

Data Inventory and Methodology

(1) Heater Treaters

Heater treaters are used to remove water from the crude oil being extracted from the wells. Normally, they are placed on the main line entering the tank battery where the crude oil is stored before shipping to the refinery. Most heater treaters burn natural gas that is tapped off the oil well. Heater treaters range in size from 4 feet to 10 feet in diameter, and consume from 20 MCF to 2.5 MMCF daily. The most common sizes are 6-8 feet and the average consumption rate is 100 MCF per day. Operating time is 24 hours per day and 9 months per year (there is little moisture during the summer) (Ref. 24).

In order to determine the number of heater treaters and their locations in the three counties, it was necessary to make two assumptions--that there is one heater treater per tank battery and one tank battery per lease (Ref. 25). The Wyoming Oil and Gas Commission was contacted to obtain the number of leases for each oil field for each county and location (Ref. 26). It was also assumed that only 90% of the heater treaters would be operating during the entire 9-month period because the units are not needed full time. Presented below are the equivalent numbers of heater treaters operating in 1974 in each county:

Campbell:	1,104
Converse:	389
Sweetwater:	258

Applying the 100 MCF of natural gas rate for 9 months (27.375 MMCF) to the number of heater treaters in each county, the annual natural gas consumption values are obtained:

Natural Gas Consumption (10^6 ft³)

Campbell = 30,222
Converse = 10,063
Sweetwater = 7,063

(2) Compressors

Compressors used in natural gas transmission are powered by either piston or gas turbine engines. The compressors are located on the pipelines which transport raw natural gas at a well site to the refinery or distribute natural gas to the customer. They burn natural gas as a fuel.

The major companies that operate pipelines in Converse and Campbell Counties were contacted. Data were obtained by manufacturer, type of engine, number of units, horsepower per unit, estimated operating time, and location (Ref. 43, 44, 45, 46, 47). All compressors were determined to have piston engines ranging in horsepower from 130 to 2000. The total number of compressors in each county is as follows:

Campbell - 93
Converse - 22

Compressors in Sweetwater County were not inventoried due to the small number of pipelines transporting natural gas from wells in this county.

Estimates of fuel consumption per unit were based on data relating horsepower to natural gas consumption per hour (Ref. 48).

Estimated Natural Gas Consumption (MMCF/yr)

Campbell - 5508.8

Converse - 352.4

Base Year Emissions

(1) Heater Treaters

Emission factors for natural gas are as follows (Ref. 12).

Emission Factors (lbs/10⁶ ft³)

Particulates - 15

Sulfur Oxides (SO₂) - 0.6

Hydrocarbons - 8

Maximum factors were used for particulates and hydrocarbons because the natural gas being burned is in a raw state.

1974 Heater Treater Emissions (tons/yr)

<u>Pollutant</u>	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
Particulates	227	80	53
SO ₂	n.c.	n.c.	2
Hydrocarbons	121	43	n.c.

n.c. = not calculated

(2) Compressors

Particulate emissions were calculated by using the average emission factor for natural gas combustion in an industrial process, 10 lb/MMCF (Ref. 12). Hydrocarbon emissions were calculated by using the non-methane emission factors for each manufacturer's engine type (Ref. 48) in lb/hour and multiplying by the number of operational hours per year.

The total emissions of particulates and hydrocarbons are as follows:

1974 Compressor Emissions (tons/year)

Campbell:	Particulates	-	27.5
	Hydrocarbons	-	187.6
Converse:	Particulates	-	4.3
	Hydrocarbons	-	41.5

Projections

DEPAD has projected oil and gas production in the three counties over the short term (1974-78) (Ref. 58); they projected that production would be relatively constant. The two industrial processes, pipeline compressors and heater treaters, are related to oil and gas production. Therefore, a change in oil and gas production would be proportional to a change in industrial process emissions. Since production will probably remain constant to 1985, it is assumed that emissions from this category will be the same for 1975, 1980, and 1985.

12. EVAPORATIVE LOSSES

Two types of evaporative losses were considered in this source category: (1) oil and gas fields; (2) gasoline transport.

The major oil and gas field hydrocarbon evaporative loss was identified as crude oil storage tanks. Additional hydrocarbon combustion emissions (from heater treaters and pipeline compressors) are presented in Section 11 of this report. Emissions from other oil and gas field sources are considered negligible (Ref. 62, 63).

The major gasoline transport hydrocarbon evaporative loss was identified as: (1) loading of tank cars and trucks; (2) loading of underground gasoline storage tanks; (3) filling motor vehicle gas tanks.

Data Inventory and Methodology

Crude oil pumped from wells is stored in tanks before shipment to the refinery. The tanks are normally the fixed roof type with a capacity of 500 barrels and a diameter of 15 feet. To determine the number of oil field storage tanks in the two counties, it was assumed that there is one tank per well.⁶² The number of wells per field are given in Reference 64. In some fields, however, a few wells have a high total production. For these fields the assumption of one tank per well is unrealistic, therefore the number of tanks was calculated using 30 turnovers per tank per year (Ref. 65). The estimated number of tanks in each county is as follows:

Campbell - 2,069

Converse - 564

The 1974 oil production in the two counties is given below (Ref. 64).

Oil Production (10³bbl)

Campbell - 34,247

Converse - 6,967

For gasoline transport, the 1974 gasoline sales for Campbell and Converse counties obtained from the Wyoming Department of Revenue were used to calculate evaporative losses. The gasoline sales are as follows:

Campbell - 11,364,386 gals

Converse - 5,927,747 gals

Base Year Emissions

Hydrocarbon emissions from fixed roof tanks occur as breathing losses and working losses. Breathing losses result when vapor is expelled due to thermal expansion, barometric pressure changes, and added vaporization of the liquid. Working losses are when emptying or filling operations cause hydrocarbon vapor to be expelled from the tank.

The emission factor for breathing losses was adjusted for a 15 ft diameter tank. The emission factors are as follows (Ref. 65).

Oil and Gas Field

Hydrocarbon Emission Factors

Breathing losses - $0.11 \text{ lb/day} \cdot 10^3 \text{ gal storage capacity}$

Working losses - $7.3 \text{ lb}/10^3 \text{ gal throughput}$

Oil and Gas Field

1974 Hydrocarbon Emissions

(tons/yr)

Campbell - 6,123

Converse - 1,306

The emission factors for gasoline transport are as follows (Ref. 65).

Gasoline Transport

Hydrocarbon Emission Factors

Tank Cars/Trucks

(submerged loading) - $4.1 \text{ lb}/10^3 \text{ gals}$

Underground Gasoline Storage

(uncontrolled submerged) - $7.3 \text{ lb}/10^3 \text{ gals}$

Filling motor vehicle gas tanks

(vapor displacement and liquid spillage) -
 $11.67 \text{ lb}/10^3 \text{ gals}$

Total Emission Factor - $23.07 \text{ lb}/10^3 \text{ gals}$

Using the total emission factor and county gasoline sales, the base year hydrocarbon emissions are as follows:

Gasoline Transport
1974 Hydrocarbon Emissions
 (tons/yr)
 Campbell - 131
 Converse - 68

Projections

In Section 11, a rationale for considering oil and gas field hydrocarbon emissions to be constant from the base year to 1985 was presented. Therefore, hydrocarbon evaporative losses will be considered constant to 1985.

For gasoline transport, growth factors were determined from projected VMT for LDV, LDT, and HDV using gasoline in Section 7. Applying these growth factors to base year emissions results in projected emissions.

	<u>Gasoline Transport</u>		<u>Gasoline Transport</u>	
	<u>Projected Hydrocarbon Emissions</u>		<u>Projected Hydrocarbon Emissions</u>	
	(tons/yr)		(tons/yr)	
	<u>Campbell</u>		<u>Converse</u>	
	<u>Growth</u>	<u>HC</u>	<u>Growth</u>	<u>HC</u>
	<u>Factor</u>	<u>Emissions</u>	<u>Factor</u>	<u>Emissions</u>
1975	1.15	151	1.02	69
1980	2.07	271	1.34	91
1985	2.53	331	1.39	95

13. UNPAVED ROADS

Data Inventory and Methodology

The Wyoming Department of Highways was contacted to obtain the following data for unpaved roads in 1974: miles of unpaved roads, average daily traffic, and average vehicle speed by surface type (Ref. 27). This data is shown for the three counties and for each highway system in Table 13.1.

Information on silt content of the road bases was also needed in order to estimate emissions. Since the average silt content of gravel roads is known to be 12% (Ref. 28), it is only necessary to determine parent soil silt content for bladed and graded and drained roads. Therefore, the Wyoming State Soil Scientist was contacted to obtain data for silt content for soils in each county (Ref. 29). Data was provided for the general soil series by percent contribution of groups of series at a given map location. A weighted average was then applied to calculate average silt content at each map location. To arrive at a county-wide silt content, an average of all locations was determined. The exception was Sweetwater County, where only 20% of the county soil series had been analyzed by the Soil Conservation Service. An average of the existing series was used to arrive at a county-wide silt content (Ref. 30). The three county-wide silt content averages were used to represent both bladed and graded and drained road surface silt content.

Base Year Emissions

Emission factors for dust from unpaved roads were obtained from a recent EPA publication (Ref. 28). Only the particulates of less than 30 microns in diameter were assumed to have impact on a regional scale, so the equation for calculating the emission rate was modified with a factor of 0.6 to account for just the sub-30 micron particles (Ref. 28):

Table 13.1. WYOMING UNPAVED ROADS 1974

SURFACE TYPE BY HIGHWAY SYSTEM	CONVERSE		CAMPBELL		SWEETWATER		ADT (Estim.)	SPEED (MPH)
	Miles of Road	% Silt Content	Miles of Road	% Silt Content	Miles of Road	% Silt Content		
Bladed (B)								
County	106.2		28.8		31.9		5	30
Federal	22.7		3.7		176.0		5	30
Local	282.8		54.3		88.9		5	30
TOTAL	411.7	22.6%	86.8	24%	296.8	18%	--	--
Graded & Drained (C)								
County	361.6		149.0		234.2		10	40
Federal	15.3		--		38.3		10	40
Local	273.0		95.3		100.2		10	40
TOTAL	249.0	22.6%	244.3	24%	372.7	18%	--	--
Gravel (E2)								
County	13.8		788.2		811.3		20	40
Federal	--		--		20.7		20	40
Local	28.5		344.1		79.2		20	40
TOTAL	42.3	12%	1132.3	12%	911.2	12%	--	--
Total miles	1103.0		1463.4		1580.7			

$$E = (0.6) \times (0.81) \times (s) \times (S/30) \quad (\text{eq. 2})$$

where E = emission factor, lb/vehicle-mile
s = silt content, percent
S = average vehicle speed, MPH

Using the data from Table 13.1, the following emission factors were calculated:

Emission Factors, lb/VMT

<u>Road surface</u>	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
Bladed	11.7	11.0	8.7
Graded & drained	15.6	14.6	11.7
Gravel	7.8	7.8	7.8

These emission factors are not corrected for wet days or days with snow cover on the roads. It is assumed that no emissions occur on these days. The annual mean number of days with 0.01 inches or more of precipitation was obtained from the map of precipitation frequency in the EPA fugitive dust publication (Ref. 28). The number of days with snow cover or freezing conditions was estimated from the National Weather Service 1974 Climatological Summary for the nearest recording station. The emission factors presented below are corrected for non-dusting days:

Corrected Emission Factors (lb/VMT)

	<u>Campbell</u>		<u>Converse</u>		<u>Sweetwater</u>	
	<u>Corr. Fact.</u>	<u>Emis. Fact.</u>	<u>Corr. Fact.</u>	<u>Emis. Fact.</u>	<u>Corr. Fact.</u>	<u>Emis. Fact.</u>
Bladed	255/365	8.2	243/365	7.3	248/365	5.9
Graded & drained	255/365	10.9	243/365	9.7	248/365	7.9
Gravel	255/365	5.4	243/365	5.2	248/365	5.3

To calculate emissions, the annual VMT was determined from the Highway Department data. Particulate emissions for each county and for each surface type are:

1974 Particulate Emissions (tons/yr)

	<u>Campbell</u>		<u>Converse</u>		<u>Sweetwater</u>	
	Annual		Annual		Annual	
	<u>VMT 10⁶</u>	<u>Emissions</u>	<u>VMT 10⁶</u>	<u>Emissions</u>	<u>VMT 10⁶</u>	<u>Emissions</u>
Bladed	0.16	656	0.75	2,738	0.54	1,593
Graded & drained	0.89	4,851	2.37	11,495	1.36	5,372
Gravel	<u>8.27</u>	<u>22,329</u>	<u>0.31</u>	<u>806</u>	<u>6.65</u>	<u>17,623</u>
TOTAL	9.32	27,836	3.43	15,039	8.55	24,588

Projections

Growth in emissions from unpaved roads is dependent on new miles of roads and increased average daily traffic (ADT). Since new industry (mainly new coal mines) will be located in rural areas with existing unpaved roads, it was assumed that miles of road will remain constant. New employees will travel from urban areas to the industrial sites and truck traffic will increase around each site. It was assumed that ADT will increase with population.

However, as the traffic volume or ADT increases, some roads will be paved. In order to incorporate this into the projected emission calculations, the following procedure was used:

- Assume a normal distribution of ADT vs. percent of total miles of unpaved roads. This distribution is shown in Figure 13.1.
- Establish base year ADT at 50 percentile and determine percent of miles exceeding 250 vehicles per day (traffic volume at which a road is paved--Ref. 63).
- Multiply growth factors by base year ADT to obtain projected ADT and determine percent of miles exceeding 250 vehicles per day for future years.
- Subtract base year percent of miles exceeding 250 ADT from each percent of miles determined for future years.
- Multiply this difference by the existing miles of road to arrive at additional miles of roads exceeding 250 vehicles per day, or miles which should be paved for each future year.
- Determine from the distribution the average ADT on roads to be paved for each future year (slightly greater than 250).
- Multiply this ADT by the additional miles of road exceeding 250 vehicles per day for each future year to arrive at VMT loss on unpaved roads due to paving.
- Multiply total base year VMT on unpaved roads by growth factors and subtract VMT loss due to paving.

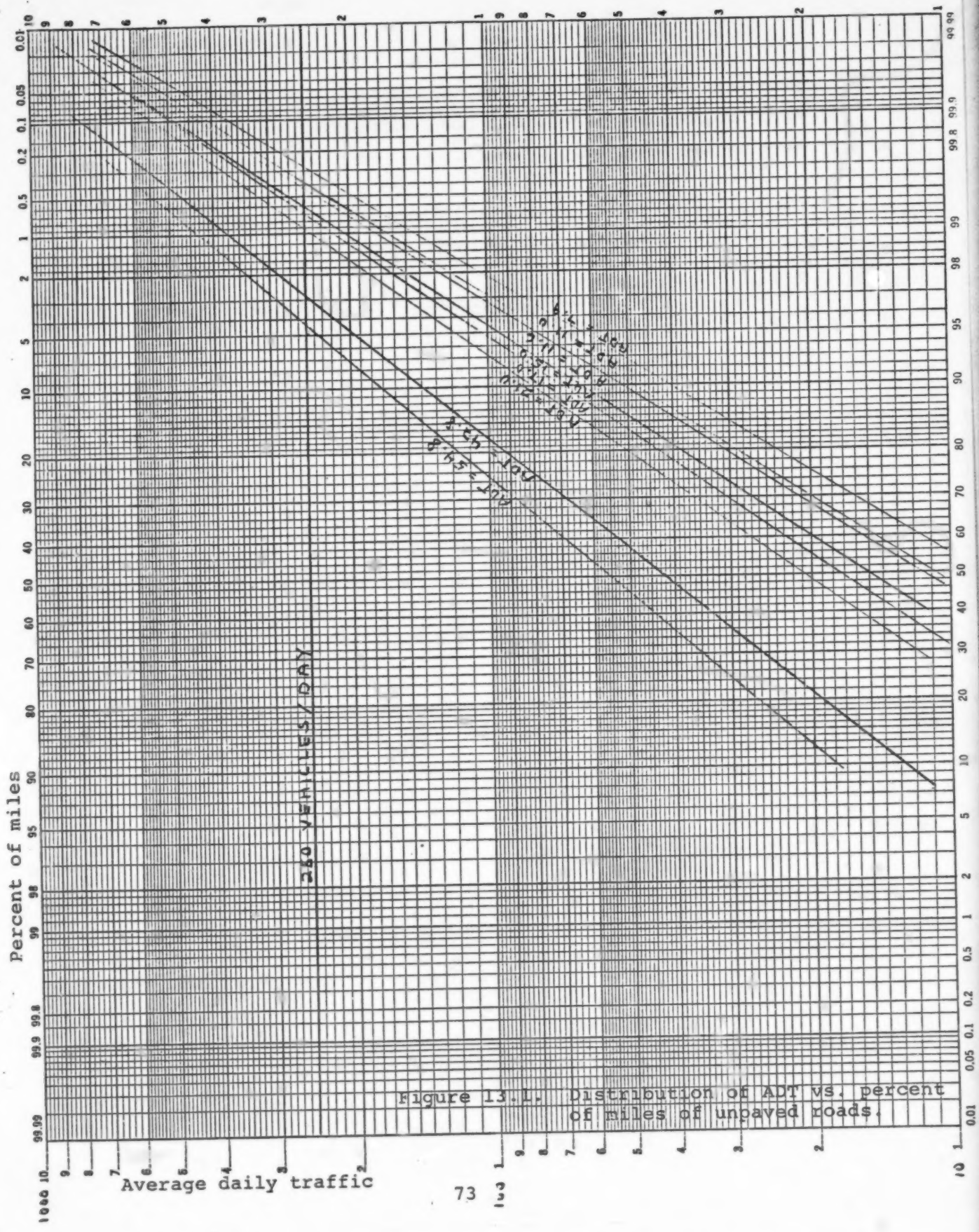


Figure 13.1. Distribution of ADT vs. percent of miles of unpaved roads.

Base year ADT for each county was determined by finding the weighted average ADT of all road surface types (miles were used as the weighting factor).

The following calculations and distribution data were used to project emissions from unpaved roads:

	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
Miles of Unpaved Roads	1463.4	1103.0	1580.7
Growth Factors			
1975	1.21	1.03	1.12
1980	2.45	1.44	1.50
1985	3.14	1.51	1.60
County-Wide ADT			
1974	17.45	7.68	14.82
1975	21.11	7.91	16.60
1980	42.75	11.06	22.23
1985	54.79	11.60	23.71
Percent Miles (distribution)			
1974	0.8	0.3	0.6
1975	1.0	0.3	0.7
1980	3.0	0.4	1.2
1985	4.5	0.4	1.4
Percent Difference			
1975	0.2	--	0.1
1980	2.2	0.1	0.6
1985	3.7	0.1	0.8
Miles to be Paved			
1975	2.9	--	1.6
1980	32.2	1.1	9.5
1985	54.1	1.1	12.6
Average ADT on Miles to be Paved (Distribution)			
1975	320	330	320
1980	330	340	330
1985	330	340	330
VMT Loss Due to Paving (annual)			
1975	338,720	--	186,880
1980	3,874,490	136,510	1,114,275
1985	6,516,345	136,510	1,517,670
Projected VMT (annual)			
1975	11,277,000	3,533,000	9,576,000
1980	22,834,000	4,939,000	12,825,000
1985	29,265,000	5,179,000	13,680,000

(Continued)	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
VMT with Assumed Paving			
1975	10,938,000	3,533,000	9,389,000
1980	18,960,000	4,803,000	11,711,000
1985	22,749,000	5,043,000	12,162,000
Particulate			
Emissions without Paving			
(tons/year)			
1975	33,681	15,490	27,538
1980	68,198	21,656	36,882
1985	87,405	22,709	39,340
Particulate			
Emissions with Paving			
(tons/year)			
1975	32,669	15,490	27,000
1980	56,628	21,060	33,678
1985	67,944	22,113	34,975

14. AGRICULTURE

Data Inventory and Methodology

There are two sources of fugitive dust from agricultural activity: wind blown dust and dust caused by tilling operations. The emissions from tilling have not been considered due to the small number of tractors operating in the three Wyoming counties during the year. Windblown dust is considered the greatest contributor to regional emissions.

The Wyoming Department of Agriculture was contacted to obtain data on acres planted for each crop type in each county for the years 1972-73 (Ref. 31). Data for 1974 was not published at the time of this analysis, so an average of the two years was used for 1974.

The following is a summary of acres planted or harvested by crop type for each county:

Acres Planted or Harvested

<u>Crop</u>	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
Wheat	21,600	2,425	--
Barley	6,550	3,350	600
Oats	4,450	3,600	900
Beans	--	500	--
Sugar Beets	--	375	--
Corn	850	2,100	--
Hay	700	11,950	7,150
Alfalfa	1,900	20,050	11,750

When the number of acres planted was not available, the average number of acres harvested was used.

Base Year Emissions

The windblown dust emission factor equation for determining particulate emissions is (Ref. 28):

$$E = a I K C L' V' \quad (\text{eq. 3})$$

where: E - emission factor, tons/acre/year

a - portion of total wind erosion losses that would be measured as particulates, estimated at 0.025

I - soil erodibility, tons/acre/year

K - surface roughness factor

C - climatic factor

L' - unsheltered field width factor

V' - vegetative cover factor

In the equation, K, C, L', and V' are dimensionless. In the EPA fugitive dust publication (Ref. 28), the map of major soil types in the Northern Great Plain states was used to determine value I. C, K, L', and V' were also obtained from data presented in the report.

A summary of the factors used to calculate emission factors by crop type are presented on the next page.

Emission Factors (tons/acre)

<u>County and Crop Type</u>	I	K	C	L'	V'	E
<u>Campbell</u>	86		.40			
Wheat		.6		.82	.04	.017
Barley		.6		.82	.07	.030
Oats		.8		.90	.02	.012
Corn		.6		.82	.56	.237
Hay		.8		.90	.02	.012
Alfalfa		1.0		.85	neg	neg
<u>Converse</u>	86		.40			
Wheat		.6		.82	.04	.017
Barley		.6		.82	.07	.030
Oats		.8		.90	.02	.012
Corn		.6		.82	.56	.237
Hay		.8		.90	.02	.012
Alfalfa		1.0		.85	neg	neg
Beans		.5		.66	.74	.210
Sugar Beets		.6		.70	.85	.307
<u>Sweetwater</u>	86		.20			
Barley		.6		.82	.01	.002
Oats		.8		.90	.01	.003
Hay		.8		.90	.01	.003
Alfalfa		1.0		.85	neg	neg

Emission factors are multiplied by the corresponding acres to arrive at total annual emissions. The particulate emissions for each crop type and county are:

1974 Particulate Emissions (tons/year)

<u>Crop type</u>	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
Wheat	367	41	--
Barley	197	100	1
Oats	53	43	3
Corn	201	498	--
Hay	8	143	21
Alfalfa	Neg	Neg	Neg
Beans	--	105	--
Sugar Beets	--	115	--
TOTAL	826	1,045	25

Projections

Data on acres planted and harvested for each crop type from 1964 to 1973 was reviewed to determine trends in agricultural activity (Ref. 61). It was assumed that the trend established during the last ten years would continue for the next ten years. For Campbell and Converse Counties, acres of wheat, oats, beans, sugar beets, corn, and hay should remain almost constant from 1974 to 1985. Barley should continue to increase about 20 percent from 1975 to 1985. For Sweetwater County, acres of barley and oats should decrease about 20 percent from 1975 to 1985 and hay acreage should remain the same. Therefore, resulting emissions are as follows:

<u>Projected Particulate Emissions (tons/year)</u>			
	<u>Campbell</u>	<u>Converse</u>	<u>Sweetwater</u>
1975	826	1045	25
1980	846	1055	25
1985	865	1065	26

15. CONSTRUCTION

Data Inventory and Methodology

For purposes of estimating emissions, three different types of construction were identified: (1) residential, commercial, and public; (2) highway; (3) industrial. The first type of construction included residential sites, shopping centers, commercial lots, schools, hospitals, recreation centers, and trailer courts. The data for acres of construction was obtained from building and planning departments in the following towns: Rock Springs (Ref. 49), Green River (Ref. 50), Gillette (Ref. 50), and Douglas (Ref. 52).

1974 Acres of Building Construction

	<u>Residential</u>				<u>Commercial</u>		<u>Public</u>	
	<u>Homes</u>		<u>Trailer Courts</u>		<u>Buildings</u>		<u>Buildings</u>	
	<u>Acres</u>	<u>Mo.</u>	<u>Acres</u>	<u>Mo.</u>	<u>Acres</u>	<u>Mo.</u>	<u>Acres</u>	<u>Mo.</u>
Campbell	11	3	65	12	8	6	19	6
Converse	12	3	--	--	1.5	6	10	4
Sweetwater	58	3	72	12	32	6	22	6

It was estimated that 1/6 acre was exposed during excavation and regrading of residential sites. It was also estimated that 1/4 acre was exposed for commercial buildings. Acreage for public buildings and trailer courts was determined for each individual construction project.

The Wyoming Department of Highways was contacted to obtain data on highway projects constructed in 1974 (Ref. 53). This data is summarized in Table 15.1. Acres of highway constructed was estimated from the miles and width of the project, and by type of construction (new or reconstruction).

The Wyoming Air Quality Division was contacted to determine which new industrial sources were under construction in 1974. The

Table 15.1 HIGHWAY CONSTRUCTION IN 1974

Project	Type	Construction	Const. Factor	Months	Miles	Width (H)	Total Acres
Campbell:	I-90	New	1.0	4	4.2	150	76.4
	I-90	New	1.0	3	3.9	150	70.9
	I-90	New	1.0	3	6.0	150	109.1
	I-90	New	1.0	6	6.9	150	125.5
	I-90	New	1.0	5	6.7	150	121.8
	Gillette St.	New and reconstr.	.66	4	0.68	30	1.7
	WYO. 59	New and reconstr.	.66	1	8.6	60	41.2
Converse:	I-25	New	1.0	4	18.9	150	343.6
	WYO. 59	New and reconstr.	.66	5	10.6	60	77.1
Sweetwater:	I-80	Reconst.	.33	7	14.7	150	88.2
	I-80	Reconst.	.33	7	15.4	150	92.4
	I-80	Reconst.	.33	7	0.1	150	0.6
	Blairtown Rd.	New and reconstr.	.66	7	4.3	30	5.1
	U.S. 30	New	1.0	4	5.5	60	40.0
	U.S. 187	Reconst.	.33	5	2.9	60	7.0
	WYO. 373	New	1.0	6	25.6	60	186.2
	WYO. 414	New and reconstr.	.66	10	5.9	60	28.3
	WYO. 530	Reconst.	.33	7	0.1	60	0.2

following is a summary of the data:

1974 Acres of Industrial Construction

	<u>Acres</u>	<u>Months</u>
Campbell -	--	--
Converse -	3	6
Sweetwater -	320	12

Base Year Emissions

The average particulate emission factor for construction is 1.2 tons per acre per month (Ref. 28). The correction factors to reflect differences in climate between the test sites used to develop the emission factors and the three counties in Wyoming are as follows:

Corrected Emission Factors (tons/acre/month)

	<u>Correction Factor</u>	<u>Emission Factor</u>
Campbell & Converse -	$\frac{(\text{PE test})^2}{(\text{PE co.})^2} = \frac{(31)^2}{(50)^2} = .384$	.46
Sweetwater -	$\frac{(31)^2}{(33)^2} = .882$	1.06

Applying these factors to each county's construction acreage and multiplying by the number of months yield the following emissions:

1974 Particulate Emissions (tons/year)

Campbell -	1485.7
Converse -	856.9
Sweetwater -	8588.4

Projections

Projected construction employment for Campbell and Converse Counties was obtained from DEPAD (Ref. 56). These data were converted to growth factors and applied to two classifications of construction: (1) residential-commercial-public; and (2) industrial. Since there are currently no construction projections for Sweetwater County, growth in construction for these two classifications was assumed to be parallel to population growth.

Projected highway construction for 1975, 1980, and 1985 was not available from the State Highway Department. An interim report by the Highway Department indicated new arterial roads that were being planned in the Rock Springs area. The report stated that approximately 96 miles would possibly be built by 1995 (Ref. 57). In order to maintain an acceptable level of transportation service, new roads and reconstruction of old roads will have to keep pace with population growth. Since the current highway construction is now meeting this demand, it is assumed that this level of construction will remain constant to 1985 in all three counties.

The following are the projected emissions for the two classifications, urban and industrial, and total projected emissions including highway construction.

<u>Projected Emissions (tons/year)</u>						
	<u>Campbell</u>		<u>Converse</u>		<u>Sweetwater</u>	
	GF	PART	GF	PART	GF	PART
Urban and Industrial						
1975	2.97	1331	1.25	59	1.12	6176
1980	4.14	1855	2.45	115	1.50	8271
1985	4.64	2079	1.20	56	1.60	8822
Total (includes highway construction)						
1975		2369		869		9250
1980		2893		925		11,345
1985		3117		866		11,896

16. AGGREGATE STORAGE PILES

Data Inventory and Methodology

Two sources were used to obtain the amount of aggregate stored in the three counties. The Wyoming State Highway Department provided the amount of stockpiled aggregate maintained by the Department for the three counties in 1974. The Wyoming Air Quality Division permit application files for 1974 were used to extract those stockpiles maintained by private industry in the three counties. Following is a summary of the data obtained for each county:

1974 Aggregate Stockpiled (tons)

	<u>Highway Dept.</u>	<u>Industry</u>
Campbell	7,407	--
Converse	7,407	8,000
Sweetwater	18,734	50,000

Base Year Emissions

The particulate emission factor for estimating the total amount of dust emissions with drift potential greater than 1000 feet (particles less than 30 microns in diameter) is as follows (Ref. 28):

$$E = (0.33) \div (PE/100)^2 \quad (\text{eq. 4})$$

where E - emission factor, lbs per ton

PE - Thornthwaite's precipitation-evaporation index

Using the map of PE values for state climatic divisions in the EPA publication Emission Factors for Fugitive Dust (Ref. 28), the PE index for Converse and Campbell counties is 50 and 33 for Sweetwater County. Therefore, the emission factors calculated for each county are:

	<u>Particulate Emission Factor (lbs/ton)</u>
Campbell -	1.32
Converse -	1.32
Sweetwater -	3.14

Applying the emission factors to the tons of aggregate stored yields the following particulate emissions for 1974:

1974 Particulate Emissions (tons/year)

Campbell -	4.9
Converse -	7.7
Sweetwater -	107.9

Projections

It is difficult to determine how much aggregate will be stockpiled from year to year. However, it is felt that the amount does not vary significantly when averaged over the long term. Therefore, it is estimated that emissions will remain constant for 1975, 1980, and 1985.

17. DUST FROM PAVED ROADS

Data Inventory and Methodology

Very little information exists on emission rates or procedures for estimating dust emissions from paved streets and highways. The American Public Works Association, the New York Interstate Sanitation Commission, and other groups are currently conducting studies to obtain data on the air pollution impact of reintrained dust from roads. PEDCo recently did a particulate emission inventory of Nashville (Ref. 54) in which it was assumed that these emissions are directly proportional to the amount of traffic (VMT).

VMT data for the three AQMA counties have already been generated to estimate exhaust emissions. The VMT on unpaved roads (also already estimated) was subtracted from the VMT totals to obtain VMT on paved roads. These data are summarized below.

<u>County</u>	1974 Annual VMT x 10 ³
	<u>Paved Roads</u>
Campbell	115,702
Converse	109,939
Sweetwater	397,884

In Wyoming, the normal amount of loose material on road surfaces is increased substantially by the periodic sanding of roads during the winter for snow and ice control. All roads maintained by the State Highway Department and major streets in most municipalities are sanded. It is assumed that sand remains on the roads after the snow has melted and the pavement has dried approximately 20 days per year.

Base Year Emissions

The emission factor derived for the Nashville study was 1.75 gm/VMT (on days with no precipitation). It was based on a single

test of a clean paved road in the Seattle area (Ref. 55). An emission factor of 77 gm/VMT has been used in some previous emission inventories for estimating emissions from sanded roads. This value was obtained from a different test site in the same study in the Seattle area (Ref. 55). If these factors are both applied in Wyoming, the average emission factors are calculated as follows:

$$\begin{aligned} \text{Campbell} - & \frac{(255-20) 1.75 + (20) 77}{365} = 5.35 \text{ gm/VMT} \\ \text{Converse} - & \frac{(243-20) 1.75 + (20) 77}{365} = 5.29 \text{ gm/VMT} \\ \text{Sweetwater} - & \frac{(248-20) 1.75 + (20) 77}{365} = 5.31 \text{ gm/VMT} \end{aligned}$$

Due to the relative inaccuracy of these factors, a value of 5.3 gm/VMT is recommended for all three counties. With this factor and the VMT data presented above, the dust (particulate) emissions from paved roads are calculated to be:

1974 Dust from Paved Roads (tons/yr)

Campbell:	676
Converse:	642
Sweetwater:	2325

It should be emphasized that the calculations in this section do not have the same accuracy as those in other sections of this report, and that the resulting emission estimates are only order-of-magnitude values.

Projections

The method and growth factors used to project motor vehicle exhaust VMT were also used to project VMT in estimating reintrained dust from paved roads. Growth factors and estimated emissions in the future years are summarized below:

<u>Year</u>	<u>Projected Emissions (tons/year)</u>					
	<u>Campbell</u>		<u>Converse</u>		<u>Sweetwater</u>	
	GF	PART	GF	PART	GF	SO ₂
1975	1.15	777	1.02	655	1.07	2488
1980	2.07	1399	1.34	860	1.29	2999
1985	2.59	1751	1.39	892	1.35	3139

REFERENCES

1. U.S. Department of Commerce, Bureau of the Census, 1970 Census of Housing, Wyoming Detailed Housing Characteristics, Washington, D. C., 1970.
2. U.S. Department of Commerce, Bureau of the Census, Wyoming County Business Patterns, Washington, D. C., 1973.
3. U.S. Department of Commerce, Bureau of the Census, Wyoming Current Population Reports, Federal-State Cooperative Program for Population Estimates, Series P-26, Washington, D. C., 1974.
4. U.S. Department of Interior, Bureau of Mines, Mineral Industrial Surveys, "Bituminous Coal and Lignite Distribution, Calendar Year 1974," Washington, D. C., 1975.
5. U.S. Department of Interior, Bureau of Mines, Mineral Industrial Surveys, "Natural Gas Production and Consumption: 1973," Washington, D. C., 1974.
6. U.S. Department of Interior, Bureau of Mines, Mineral Industrial Surveys, "Sales of Fuel Oil and Kerosene in 1973," Washington, D. C., 1974.
7. U.S. Department of Interior, Bureau of Mines, Mineral Industrial Survey, "Sales of Lignefied Petroleum Gases and Ethane in 1972," Washington, D. C., 1973.
8. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Center, Local Climatological Data, 1974 Annual Summary with Comparative Data, Asheville, North Carolina, 1974.
9. Wyoming Department of Environmental Quality, Air Quality Division, Open Burning Log, 1974.
10. U.S. Forest Service, Rocky Mountain Regional Office, Individual Fire Report Data-Computer Summary, 1974.
11. U.S. Environmental Protection Agency, Guide for Compiling a Comprehensive Emission Inventory, APTD 1135, March 1973.
12. U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, second edition, AP-42, April 1973.

13. Ryckman, Edgerly, Tomlinson and Associates, Inc., unpublished file data provided by U.S. Navy.
14. Wyoming State Highway Department, Planning Division, Wyoming Traffic, April 1975.
15. Wyoming Department of Revenue, Commercial Vehicle Section, Communication with Mr. Zeman, May 1975.
16. U.S. Department of Commerce, Bureau of the Census, Census of Agriculture, County Data, Washington, D. C., 1969.
17. U.S. Geological Survey, Casper, Wyoming. Communication with Ken Moore, Research Chemist, June 1975.
18. Public Service Commission of Wyoming, Rate and Tariff Department, Railroad Track Mileage for Wyoming, Sept. 1969.
19. Burlington Northern Railroad Company, Denver, Colorado. Communication with Mr. Edmonds, Transportation Section, June 1975.
20. Chicago and Northwestern Railroad, Casper, Wyoming. Communication with Mr. Dick Fadler, June 1975.
21. Wyoming Department of Economic Planning and Development, Study of the Economic Feasibility of Providing Third Level Air Carrier Service in Wyoming, December 1974.
22. Rock Springs Municipal Airport. Communication with Mr. Wachtel, Airport Manager, June 1975.
23. Gillette Aviation, Antelope Airlines, June 1975.
24. Continental Oil Company, Casper, Wyoming. Communication with Mr. W. C. Blackburn, Production Manager, June, 1975.
25. Wyoming Oil and Gas Conservation Commission, Casper, Wyoming. Communication with Mr. Basko, State Oil and Gas Supervisor, June 1975.
26. Petroleum Information Corp., Oil and Gas Production Report Wyoming, 1974.
27. Wyoming Department of Highways, Traffic Planning Division. Communication with Paul Joslin, April 1975.
28. U.S. Environmental Protection Agency, Development of Emission Factors for Fugitive Dust Sources, EPA-450/3-74-037, June 1974.

29. U.S Department of Agriculture, Soil Conservation Service, Casper, Wyoming. Communication with Clarence J. Fowkes, Assit. State Soil Scientist, May 1975.
30. University of Wyoming, Agricultural Experiment Station, "Characterization Data of Selected Soils from Sweetwater and Fremont Counties, Wyoming, Science Monograph 13, August 1968.
31. Wyoming Department of Agriculture, Wyoming Agricultural Statistics, 1972-73.
32. Wyodak Coal Company, Gillette, Wyoming. Communication with Bud Wester, June 1975.
33. Sweetwater Coal Yard, Rock Springs, Wyoming. Communication with Zuezk Coal Distributor, June 1975.
34. Best Coal Company, Converse County, Wyoming, June 1975.
35. Petrolane-Wyoming Gas Service, Gillette, Wyoming. Communication with Don Arensmeyer, Manager, June, 1975.
36. Standard Oil Company, Douglas, Wyoming. Communication with Tom Christy, LP Gas distribution manager, June 1975.
37. U.S. Geological Survey, Laramie, Wyoming. Communication with Gary Glass, June 1975.
38. Fulkerson Oil, Gillette, Wyoming. Communication with Bill Fulkerson, May 1975.
39. Link Standard Oil, Douglas, Wyoming. Communication with Mrs. Link, May 1975.
40. Red Horse Oil, Rock Springs, Wyoming. Communication with Pete Bunning, June 1975.
41. Wyoming Department of Environmental Quality, Air Quality Division, Point Source Air Contaminant Emission Reports, 1974.
42. Final Environmental Impact Statement. Eastern Powder River Coal Basin of Wyoming, Department of Interior, October 1974.
43. McCulloch Interstate Gas Company, Casper, Wyoming. Communication with Mr. Ouets, Operations Manager, June 1975.
44. Kansas-Nebraska Natural Gas Company, Inc., Hastings, Nebraska. Communication with Mr. Drake, Operations, May 1975.

45. Mountain Fuel Supply Company, Salt Lake City, Utah. Communication with Mr. A. J. Marushack, Chief Engineer of Gas Supply Operations, June 1975.
46. Atlantic Richfield Company, Rocky Mountain District, Denver, Colorado. Communication with Mr. W. A. Walther, District Production and Drilling Superintendent, June 1975.
47. Phillips Petroleum Company, Casper, Wyoming. Communication with Mr. F. C. Morgan, Superintendent, June 1975.
48. Southwest Research Institute, Exhaust Emissions from Piston and Gas Turbine Engines used in Natural Gas Transmission, prepared for American Gas Association, AR-923, January 1974.
49. Rock Springs Planning and Development, Rock Springs, Wyoming. Communication with Bill Banks, Planner, June 1975.
50. Town of Green River, Wyoming Building Inspector's Office, June 1975.
51. Campbell County Planning Office, Gillette, Wyoming. Communication with Bernie Schnorenberg, City and County Planner, June 1975.
52. Town of Douglas, Douglas, Wyoming. Communication with Joe Keefer, Building Inspector, June 1975.
53. Wyoming Department of Highways, Wyoming Construction Bulletin, monthly publication, January-December, 1974.
54. Particulate Area Source Emission Inventory for Nashville-Davidson County, Tennessee. PEDCo-Environmental Specialists, Cincinnati, Ohio, February 1975.
55. Roberts, J. W. et al. The Measurement, Cost and Control of Traffic Dust in Seattle's Duwamish Valley. Paper No. AP-72-5. Presented at the APCA Pacific Northwest Section Annual Meeting, Eugene, Oregon, November 1972.
56. Wyoming Department of Economic Planning and Development, Coal and Uranium Development of the Powder River Basin--An Impact Analysis, June 1974.
57. Wyoming Department of Highways, Planning Branch, Interim Report--Rock Springs Green River Area Transportation Planning Process, September 1974.
58. Wyoming Department of Economic Planning and Development, 1974 Wyoming Mineral Yearbook, 1974.

59. Wyoming Department of Agriculture, Wyoming Agricultural Statistics, November 1973.
60. Wyoming Department of Economic Planning and Development, Coal Development Alternatives, December 1974.
61. Wyoming Department of Highways. Communication with Mr. Jack Warburton, Planning Section, July 1975.
62. Wyoming Oil and Gas Conservation Commission, Casper, Wyoming. Communication with Mr. Donald Basko, State Oil and Gas Supervisor, September 1974.
63. American Petroleum Institute, Division of Production, Dallas Texas. Communication with Mr. Lyles, August 1975.
64. Wyoming Oil and Gas Conservation Commission, Wyoming Oil and Gas Statistics, 1974.
65. U.S. Environmental Protection Agency, Office of Air and Water Programs, Compilation of Air Pollutant Emissions Factors (second edition with four supplements), Research Triangle Park, North Carolina, April 1973.